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LE CAIRE
IMPRIMERIE DE L'INSTITUT FRANÇAIS
D'ARCHÉOLOGIE ORIENTALE
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INSTITUT D'ÉGYPTE

COMMUNICATIONS ET PROCÈS-VERBAUX



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TABLE DES MATIÈRES

PROCÈS-VERBAUX

L'HORLOGE DU PALAIS [1]

PAR

BISHR FARÈS

Recueillie par le Musée d'art islamique, au Caire, n° 14017, cette miniature a 25 mm. de haut et 14 mm. de large. Peinte sur un papier de lin crème, elle est en excellent état, malgré quelques déteints (pl. I) [2].

Trois personnages : deux hommes et une jeune femme dans un palanquin. Puis un paon, un oiseau, un monstrueux serpent à deux têtes et une éléphante. En marge, à gauche, une inscription arabe originale indique le mécanisme de l'horloge : « *Et voici l'image du palais, représentant l'horloge. Quand la durée d'une heure s'écoule, l'homme* (en bas, un nègre) *cogne le crâne de l'éléphante, et l'autre, le scribe* (en haut), *marque une heure sur la tablette; tandis que le paon, tout en haut du palais, siffle, et siffle aussi l'oiseau dans la gueule du serpent, et à travers celle-ci tombe du bec de l'oiseau ce qui sert à frapper sur le vase, ainsi que nous te l'avons décrit* ».

La jeune femme porte un châle bleu et une robe verte. Le scribe a un vêtement bleu rehaussé d'orangé ; il tient des deux mains une tablette. Le nègre, un maillet dans la main droite et une pointe à tête plate maintenue par la main gauche, exhibe une pèlerine orangée et un pantalon blanc. Le paon est bleu, vert, or ; l'oiseau bleu ; le serpent lilas ; l'éléphante gris bleu, avec une sangle rouge. La bannière, rouge, est cernée d'or ; or, blanc, rouge et bleu se disputent la décoration du palanquin, alors que le lion est ocre.

Cette œuvre, née d'un sentiment exquis autant que d'une pratique alerte, est agréable, en dépit de son objectivité technique et de son intention savante. Un balancement harmonieux, une facture accomplie,

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[1] Communication présentée en séance du 10 novembre 1958.

[2] Photo Musée d'art islamique, Le Caire. — Je remercie mon confrère A.M. Ḥamdî, conservateur du dit Musée, de m'avoir facilité l'étude de ce document.

certains détails savoureux exaltés par des couleurs fluides en font un éloquent produit de l'Ecole dite de Bagdad, issue en grande partie du courant hellénistique; école syro-mésopotamienne, répandue dans les régions arabes, avant l'entrée de l'esthétique extrême-orientale ou bien avant son extension [1].

On peut classer ce monument vers la fin du XIIIe siècle ou au début du XIVe, en raison de sa méthode picturale et du style calligraphique de l'inscription marginale. Certains éléments sont familiers aux peintres arabes : le paon faisant la roue est un motif courant [2], le monstrueux serpent à tête de dragon apparaît sur le frontispice de la *Thériaque* de Paris, manuscrit daté 595 H./1199 [3]; l'éléphante revient sur deux images : l'une de la fin du XIIIe siècle, enrichit un album à Topkapi [4], l'autre décore un *Bestiaire* de l'an 755 H./1354 [5]; enfin, le palanquin allonge la liste établie par R. Ettinghausen [6].

Maintenant isolée, cette miniature appartenait certes, jadis, à un manuscrit. Elle ne semble pas avoir été arrachée à une copie, aujourd'hui dépecée, des *Automates* d'al-Djazarī, sortie en 1354 d'un atelier égyptien [7].

(1) Un autre spécimen des œuvres demeurées à l'abri des infiltrations asiatiques vient d'être offert par le frontispice des *Règles fondamentales* d'Ibn al-Muṭahhar: B. Farès, *Philosophie et Jurisprudence illustrées par les Arabes,* in *Mélanges Louis Massignon,* Inst. fr. de Damas, Beyrouth 1957, II, p. 89-92, pl. VI.

(2) Par ex.: E. Blochet, *Musulman Painting,* Londres 1929, pl. XXXV.

(3) B. Farès, *le Livre de la Thériaque,* Inst. fr. d'arch. or., Le Caire 1953, hors-texte fig. 1, pl. III, IV; d'autres exemples sont cités et analysés au cours du texte : p. 29-32.

(4) F. Sarre et F. R. Martin, *die Ausstellung von Meisterwerken Muhammedanischer Kunst in München* 1910, Munich 1912, I, pl. 8 *b* (L'album contenant cette image est maintenant coté : *Hazine* 2152; elle occupe toujours le folio 60 v°; trop dégradée, je n'ai pu en avoir, à mon tour, qu'une médiocre reproduction photographique).

(5) E. de Lorey, *le Bestiaire de l'Escurial,* in *Gazette des Beaux-Arts,* décembre 1935, fig. 2.

(6) R. Ettinghausen, *Notes on the Lusterware of Spain,* in *Ars Orientalis,* I (1954), p. 137 et suiv.

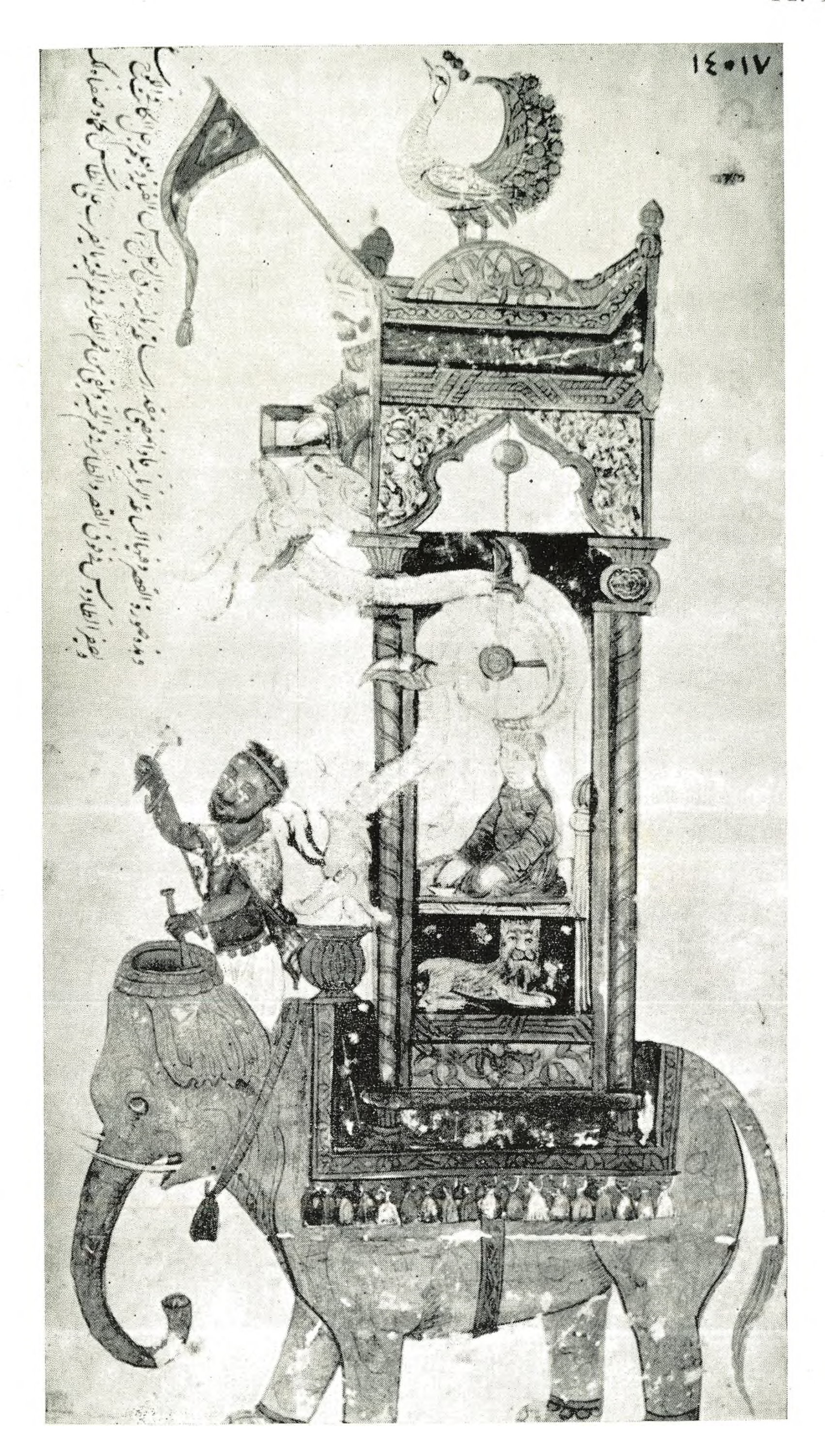
(7) Cf. K. Holter, *die islamischen Miniaturhandschriften vor 1350,* in *Zentralblatt für Bibliothekswesen,* LIV, 1/2 (1937), p. 6-7, n° 13; Buchthal, Kurz, Ettinghausen, *Supplementary Notes to K. H.'s Check List...,* in *Ars Islamica,* VII, 2 (1940), n° 13;

Ornait-elle une autre copie de cet ouvrage, dont nous connaissons plusieurs exemplaires illustrés, le plus lointain ayant été achevé en 602 H./1206 [1]? Elle a pu aussi embellir un traité sur la fabrication des horloges, tel ce *ʿIlm as-sāʿāt wa'l ʿamal bihā,* composé en 618 H./1230 par Riḍwān ibn Muḥammad al-Khurasānī et dont une copie agrémentée de nombreux dessins est parvenue jusqu'à nous [2].

Z. M. Ḥasan, *Madrasat Baghdād fi't-taṣwīr al-islāmī,* in *Sumer,* XI, 1 (Bagdad 1955), p. 16-17, pl. 5, 6; Idem, *Aṭlas al-funūn az-zukhrufīyah wa't-taṣāwīr al-islāmīyah,* Le Caire 1956, p. 307-308, fig. 884-886.

(1) Holter, *op. cit.,* n° 10; B., K., Ettinghausen, *op. cit.,* n° 10; B. Farès, *L'art sacré chez un primitif musulman,* in *Bulletin de l'Institut d'Egypte,* XXXVI, 2, session 1953-1954 (1955), p. 668, pl. XI *b*.

(2) Brockelmann, *GAL,* Weimar 1898, I, 473, n° 6. — Une copie récente de ce traité, renfermant plusieurs dessins, exécutée en 1332 H./1913, se trouve à la Bibliothèque nationale du Caire, *Taymūrīyah, ṣināʿah* 24 : cf. A. Taymur et Z. Ḥasan, *at-Taṣwīr ʿind al-ʿArab,* Le Caire 1942, p. 42-43, 181-182.



SOIL MICROFLORA IN RELATION TO GROWTH AND DISTRIBUTION OF DESERT PLANTS [1]

BY

MONTASIR, A. H. AND ELWAN, S. H.

I. — INTRODUCTION.

The desert region is the largest phytogeographical region in Egypt, embracing a total area of about 960,000 sq. kms. Ecological studies have been carried out during the last 25 years to try to correlate the physicochemical characteristics of soils with the growth and the distribution of plants in various representative desert localities. Special care was given to soil density, penetrability, aeration, water table, humus content, carbonate content, *p*H value, and other factors affecting growth and distribution of plants (2).

In the desert region, the air temperature varies between 10.0 and 30.0° C. Maximum values of 40° C. or 45° C. at 2-3 p.m., in summer, and minimum values of 0-5° C., at 4-6 a.m. in winter have been recorded. The soil temperature range at 1 cm. below soil surface is great, this range diminishes to 20-30 % of its value at 10 cm. and to 4 % of its value at 3o cm. deep. The desert region is considered to be relatively dry ; annual means of relative humidity of 54-66 % is common. The annual rainfall varies between 16 and 31 mm. in the studied localities. Sand storms are common in the desert causing excessive evaporation and moving mobile sand dunes. Small annual plants suffer badly from heavy storms.

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[1] Communication présentée en séance du 10 novembre 1958.

The evaporation power in the desert region varies between 3.47 mm. in December and 11.13 mm. in June, with an annual mean of 7-10 mm.

Dew is considered to be a source of water for some desert plants. It was determined indirectly as an increase in the water content of the soil at a depth of 0-5 cm.

It was found that soil moisture began to rise at 3-4 p.m. and reached a maximum at 6 a.m. because of the deposition of dew. At lower depths of the soil the effect of dew becomes negligible.

Coarse and fine sand form most of the constituents of the soil in the desert localities. Silt and clay are rather inconspicuous. In few cases, however, samples taken from beds of valleys after a heavy rain, show a rise in silt and clay fractions. The high percentage of coarse and fine sand fractions (90-95 %) has its effect on the water content of the soil salinity content, humus content as well as nitrate content. The total water content in the different localities studied in the desert region varies between 1 and 8 %. It increases with depth and in the active region of absorption fulfills the minimum requirements of plants to keep alive. Most of the water is evaporated at ordinary temperature and only a small amount is left for the high temperature of the oven to expel.

The amount of the humus content in desert regions varies between 0.1 and 3.6 %. The amount of water soluble salts is very low; it is in most cases less than 0.5 %. Except in very few cases, the amount of soluble salts is less at the lower depths than at the upper ones.

Carbonate content is considered to be low in many regions such as Suez Road, Almaza, Wadi Melaha, Wadi Saki and Gebel Asfar. In other localities such as Wadi Digla, W. Hof, W. Rashrash, on the other hand, the percentage of carbonate content is relatively high, where it reaches up to 40 %. Some plants are indifferent to $CaCo_3$, while others are more or less carbonate indicators. *Zygophyllum coccineum,* is a carbonate indicator. In Suez Road, the plant is almost absent in the first 50 km. where the Co_3 content is low. Whenever the plant is found, the soil on which it grows has been found to contain a high percentage of $CaCo_3$.

The nitrate content proved to be low in the localities studied. However, soil supporting *Zygophyllum simplex* and *Alhagi maurorum,* contain appreciable amounts of nitrates, probably due to the presence of root nodules with their nitrogen fixing bacteria on the roots.

The range of *p*H in the desert soils, is wide; it varies between 6.8 and 9.1. As to the reaction of soil solution at different depths, it was found that the solution is generally slightly less alkaline at lower levels, due to the evaporating power of the atmosphere which brings salts upwards.

The xerophytic plant community is an open climatic climax and more or less stable. The associations are in patches and are separated by large spaces of bare ground (1). The physico-chemical characteristics of desert soils are of the causal factors in developing the xerophytic community. The studying of the factors affecting the root development of desert plants has designated the significance of soil moisture, water table, soil density and soil structure, as major factors in the root development of such plants. The increase of the nitrate content in the soil supporting *Z. Simplex* and *Alhagi maurorum,* over that supporting *Zilla spinosa,* and the presence of root nodules on the former and not the latter, has directed attention towards the role of microorganisms in the desert soil. The significance of this direction is that it may throw some light on the question of mutual interrelationships between the higher plants and the microorganisms in the desert severe habitat.

The possible role played by microorganisms in influencing the relative frequency and vigour of certain higher plants, has been recently emphasized by many investigators (Callison 1944, Waksman 1938, Timonin 1939, Thompson 1942, Garrett 1944, Wilson 1947, Wilson and Burris 1947, McCalla and Duley 1948 and McCalla 1949).

Accordingly, attention has been directed towards the following lines of investigation :

1. A survey to investigate quantitatively the number of fungi and bacteria in the root region «rhizosphere» and in the neighbouring soil, at a distance of a few cms.

2. The probable effect of the most common associated rhizospheric fungi and bacteria on the root development of a representative xerophyte.

3. The probable effect of the root metabolic activity on the potentialities of the associated fungi and bacteria.

4. The hydrolytic potency of the associated microorganisms, rendering the unavailable organic compounds such as cellulose, starch and proteins, accessible for direct utilization.

These lines have been traced to discuss the significance of the root in the desert soil as an important «microhabitat» for an underground microvegetation. The relation between this «microvegetation» and the individual development of the above «macrovegetation», has been studied.

II. — METHODS.

The methods adopted for chemical and mechanical analysis of soil and for microbiological analysis of the rhizosphere and the neighbouring soil, have previously been described (2 and 3). The methods of evaluating the hydrolytic potentialities of the microorganisms, have also been described (3, 4 and 5).

III. — RESULTS AND DISCUSSION.

Both fungi and bacteria are highly represented in rhizosphere of all the investigated plants and in the soil far from the root system (Table 1). Bacteria are more represented than fungi in the rhizosphere. The ratios given (in Table 1), are calculated from the mean counts of fungi and bacteria dominating various rhizospheric and soil horizons.

Regarding the distribution of fungi and bacteria in various localities, a striking similarity has been observed in relation to each individual plant, irrespective of locality variance (2 and 3). Fungal and bacterial counts showed an increase with the increase of depth in *Farsetia* rhizosphere and

TABLE 1

Rhizosphere : soil (R : S) ratios of fungi and bacteria, and bacterial : Fungal (B : F) ratios of rhizosphere and soil, of representative desert plants and localities.

Plant		Z. cocci-neum	Fagonia arabica	Alhagi maurorum	Helio-tropium luteum	Farsetia aegyp-tiaca
Locality		Wadi Digla	Gebel Asfar	Gebel Asfar	Gebel Asfar	Suez Road
R : S ratio	Fungi	35.6	21.0	14.6	49.3	4.5
	Bacteria	56.9	23.1	5.4	30.6	7.2
B : F ratio	Rhizosphere	16.7	8.5	2.6	0.5	3.3
	Soil	10.4	7.5	7.5	7.5	1.7

in the neighbouring soil 20-30 cm. distant. This may be attributed to the saturation capacity up-down increase, or to the increase of roots vital activity with the approach of the tip (5 and 6). However, the rhizosphere represents an important region in the desert soil, in which fungi and bacteria find the suitable substratum for existence. In *Farsetia* rhizosphere, *Aspergillus terreus* was the most frequent fungus, and *Bacillus subtilis* the most common bacterium (4). Both these organisms are spore formers, thermophilic and growing fairly well in slightly alkaline media. The previous description of the desert habitat indicates the adaptability of the two common microorganisms to such environment. The dominance of the spore formers in the rhizosphere and in the soil, may be a character for the desert soils, since it is generally known that the spores are more resistant to diverse conditions than the vegetative phases.

The increase of fungal and bacterial counts with depth is accompanied by an increase in humus content, saturarion capacity and total carbonates. Fungal and bacterial counts were more abundant in the rhizosphere

than in the soil. Cultural studies proved that the optimum conditions for growth of some rhizospheric microorganisms prevail in the Egyptian deserts.

The mentioned results directed attention towards the role played by the metabolities of higher plants in influencing the germination and growth of the microorganisms. The seedlings of some desert plants were allowed to grow on a synthetic medium under aseptic conditions and the effect of root metabolities on the conidial germination, mycelial growth and colonial growth of certain fungi and bacteria, namely *Aspergillus terrus* and *Bacillus subtilis,* were observed. Various nitrogen sources at different initial *p*H values were tried.

The greater abundance of such mircroorganisms in the rhizosphere than in the surrounding soil may be ascribed to the production of growth promoting metabolites. These growth promoting metabolites are not specific for roots of certain plants but occur in a great number of plants related to each other. This has been manifested by the induction of spore germination and mycelial or colonial growth of the microorganisms by the root metabolites obtained in synthetic media. These results emphasize the significance of the rhizosphere as an important micro-habitat in the desert soil.

On the other hand, the microorganisms produce growth promoting factors that increase the root development of the higher plants. This has been manifested by soil experiments in which the seeds are irrigated since sowing, by metabolites of the microorganisms, obtained on various physiologically and environmentally modified media. The metabolites were applied either autoclaved or cold sterilized.

To determine the thermic character of these metabolites, fractionations of the metabolites by ethyl ether and petroleum ether have been carried out, and irrigations with these fractions solutions have been applied. The results have shown that thermostable ethyl-ether-soluble growth promoting substances are present in the metabolites. Such metabolites have been proved to be of auxin and vitamine nature. They induced the growth of avena coleoptile indicating the auxin nature, and the colonial growth of *Lactobacillus casei,* indicating the vitamin nature (vitamin B complex).

Moreover, microorganisms that are able to fix atmospheric nitrogen have been regularly isolated from the rhizosphere. *Azotobacter* spp. were isolated from the rhizosphere of plants in different localities. These nitrogen fixers have been found to grow well and eventually to fix atmospheric nitrogen under conditions similar to those prevailing in the desert.

Rizospheric microorganisms have also been able to decompose cellulose, starch and proteins into simple compounds, that can be utilised by the plant. Reducing sugars and aminoacids produced as a result of decomposition processes, can be utilized by *Azotobacter,* thus producing more favorable conditions for nitrogen fixation. Thus, there is mutual benificial interaction between the plant and the microorganisms on one hand, and between the microorganisms on the other hand. Decomposition processes also have a benificial effect in ameliorating the soil characters, increasing the humus content and other physical and chemical characteristics of the soil.

In conclusion, it may be stated that the microorganisms play an important role in the distribution and growth of plants of the desert community.

IV. — REFERENCES.

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تأبين

محمد كامل مرسى (١) (1)

لحامد زكى

منذ نحو عام اختار الله لجواره زميلنا وصديقنا المرحوم الدكتور محمد كامل مرسى ، وإنه لمن فضول الكلامَ أن أقول مع القائلين إن مصابنا فى الراحل كان عظيما . فكلمتى الليلة ليست تعبيراً عن حزن ولا استدعاء لعزاء ، وهى لا تعدو التنويه بفضل الفقيد علينا نحن الأحياء بعده ، من طريق آثاره العلمية التى خلفها لنا .

والحق أن أبحاث الفقيد ومؤلفاته تشعرنا أن صاحبهـا لا يزال بقيد الحياة . وإننا رجال القانون فى مصر بل فى البلاد العربية نحس بمرافقته لنا فى تفكيرنا ، كلما شق علينا التفتيش عن رأى صائب أو الاهتداء إلى فكرة سديدة فى نطاق عملنا .

وأحسب أن القاضى لا غنى له عن الرجوع إلى مؤلفاته ، وأن المحامى لا بد له أن يستنير بآرائه وشروحه . أما الأستاذ الجامعى فلا يستطيع أن يعرض عن التعمق فى دراسة كتبه ورسائله قبل أن يحاول إضافة جديد فى عالم القانون .

ومن أهم ما تميز به فقيدنا العزيز أنه كان دؤوباً على العمل فى صبر نادر المثال ، فكنت تراه من صباحه إلى مسائه مقبلا على القراءة والتفكر والكتابة لا يكلّ ولا يملّ ، وما من نقطة أو مسألة درسها إلا استظهر نواحيها وأطرافها واستعرض ما جاء به السلف فى شأنها سواء من علماء الغرب كانوا أو من علماء الشرق ، وأقصد بوجه خاص علماء الشريعة الغرّاء . وفى حقل الشريعة

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(١) ألقى بجلسة ١٠ نوفبر سنة ١٩٥٨ .

(1) Notice nécrologique sur feu Mohamed Kamel Moursi par Hamed Zaki, présentée en séance du 10 novembre 1958.

يحق لنا أن نفاخر بالجهد العظيم الذى بذله الفقيد فى استخراج الكنوز المدفونة فى بطون الكتب القديمة . ثم فى عرضها وبسط مطالبها فى سهولة وسداد منهج ، مع مقارنتها بمذاهب العلماء المعاصرين ، حتى يخرج من كل ذلك برأى يوافق ألوان التطور من حياة العصر .

ولكم أفاد زملاؤنا أساتذة القانون الأجانب من جليل أبحاثه فى الفقه الإسلامى ، حتى إنها صارت أساساً لكثير من الدراسات المقارنة التى ظهرت فى الفقه الفرنسى الحديث .

ولقد برزت كفاية فقيدنا فى سن مبكرة ، إذ أهلتـه مؤلفاته العلمية فى شبابه ، وهو دون الأربعين ، إلى أن تعين وكيلا لكلية الحقوق فى سنة ١٩٢٧ ثم أصبح عميداً لها فى سنة ١٩٢٨ ، وكان قد كتب فى أصول القانون أى فلسفته مؤلفاً بالاشتراك مع زميله الراحل المرحوم السيد مصطفى ، رئيس محكمة النقض الأسبق . كما أنه كان قد أخرج مؤلفاً آخر فى القسم العام من القانون الجنائى . وهذا المؤلف الصغير كان لى وللزملاء أيام التحصيل مرجعاً مكيناً وإلى جانبه بعض بحوث أخرى فى القانون المدنى نشرها فى سنة ١٩٢٣ ، وما أن عاد الفقيد إلى كلية الحقوق بعد أن تركها بضع سنوات إلى السلك السياسى حتى انكبّ على التأليف فى القانون المدنى ، فوضع مصنفه الموجز فى الملكية والحقوق العينية سنة ١٩٢٧ ، ولهذا الموجز شأن خاص فى إنتاج الفقيد ، إذ ترجع أسسه إلى رسالة الدكتوراه التى قدمها فى سنة ١٩١٤ بجامعة ديجون ، ثم أصبح هذا منبعاً لسيل منهمر من الأبحاث الموسعة باللغتين العربية والفرنسية ، نراها منشورة فى مختلف المجلات القانونية المصرية والفرنسية فى مصر والخارج فى سنوات متعاقبة منذ سنة ١٩٣١

ولما انتظم عقد هذه الأبحاث وتكامل أقبل الفقيد على استيعاب مسائلها وتنسيق فوائدها فى مطوّل استغرق أربعة أجزاء ، موضوعه الملكية والحقوق العينية ، تم خروجه سنة ١٩٣٦

واتفق أن عصفت رياح السياسة بالفقيد فى آخر سنة ١٩٣٧ ، فخرج من كلية الحقوق حزيناً آسفاً . ولكن محكمة النقض تلقته على الرحب ، فعمل

فيها مستشاراً إلى أن أصبح وكيلا لها . على أن اشتغاله بالقضاء العالى لم يقف حائلا دون استمراره فى البحث العلمى والتأليف المبتكر . ومن ثم شرع الفقيد فى إخراج مؤلف واسع شامل للقانون المدنى بجملته ، وبينما هو فى تحقيق مشروعه إذا هبات السياسة تضطره إلى الاستقالة من محكمة النقض ، فدخل إلى عالم المحاماه .

ولكن ربّ ضارّة نافعة ، فالسنوات التى قضاها الفقيد مستشاراً ثم محامياً لوّنت مؤلفه الضخم بطابع عملى ظاهر ، إذ نراه قد أدخل على أساوبه فى التأليف طريقة جديدة ، فالى جانب الأسلوب التعليمى التقليدى للكتب الدراسية قامت الطريقة المقارنة وقد احتلت مكاناً كبيراً بحيث جاوز البحث الشريعة الإسلامية إلى غيرها من الشرائع والقوانين السائدة فى مختلف البلاد العربية وغيرها ، وقامت أيضاً الطريقة التحليلية بما فيها من توسع وتبحر ، وينتهى ائتلاف هذه الطرائق إلى طريقة جامعة ، معها يستوى تحديد النظام القانونى ويتضح الرأى الجدير بالمشرع أن يتبعه فى المسألة الخلافية ، وعلى هذا النحو برزت الخطة العملية فى مؤلفاته إلى جنب الخطة النظرية حتى إننا نرى عرضاً شاملا لأحكام القضاء فى متنوع المنازعات ، كما نلمس استخلاصاً دقيقاً للمبادىء والقواعد السديدة يأتى هدى للباحثين .

ولقد سلخ فقيدنا قرابة عشر سنوات فى إخراج مؤلفه الشامل فى شرح القانون المدنى إلى أن امتدت يد المشرع إلى المجموعة المدنية القديمة فألغتها برمتها واستعاضت عنها بمجموعة جديدة نافذة منذ ١٥ أكتوبر سنة ١٩٤٩ ، وهى مجموعة تختلف اختلافاً ملحوظاً عن سابقتها ، فى مصادرها وأسسها الاقتصادية والاجتماعية . ولكن ذلك لم يفت فى عضد كامل مرسى بل أصر على أن يساير التقنين الجديد بالدرس والتأليف ، فأخرج للمشتغلين بالقانون مؤلفاً جامعاً شرح فيه الأحكام الجديدة شرحاً وافياً لم يسبقه إليه أحد . وكانت محاولته غاية فى التوفيق ، وقد أدهشت أكثرنا بسرعة خروجها ثم أصبحت رغم أنوف نفر من الناقدين منارة يستبصر بها القضاء والفقه فى محيط التقنين المستحدث .

هذا وفى اعتقادى أنه لوكان العمر امتد بفقيدنا بعض الوقت لكان جاد بمباحث موسعة لا نزال فى مسيس الحاجة إليها .

ومن هنا إحساسنا بعظم المصاب ، وليس لنا إلا الأمل فى أن يقوم من بيننا من يسد هذه الثلمة بعد أن رضينا بقضاء الله .

وحتى يتحقق الأمل علينا أن ندعو المولى الرحيم أن يرحم الفقيد وأن يحله منازل أحبابه من العلمـــاء النابهين . وحسب أصدقائه وزملائه عزاء أن الله قد رفعه فى حياته إلى أسنى المراتب وسمح بعد وفاته بثناء جميل على شفاه أبناء أمته .

وإن المجمع العلمى ليحتفظ فى سجلاته للراحل الكريم بآيات من الخدمات الجليلة أسداها إليه ، وآخر الآيات أنه نظر فى النظام الأساسى للمجمع فتناوله بالتنقيح والتوضيح وصاغه فى أسلوب قانونى رائق فائق .

وإن أعضاء المجمع ليبتهلون إلى المولى القدير الكريم أن يجزينا عن فقيدنا العزيز جزاء الصابرين .

ON THE NATURE OF CERTAIN PEAR-SHAPED CELLS IN THE INTESTINAL EPITHELIUM OF FISH[1]

BY

A. H. AL-HUSSAINI

FOREWORD

The intestinal epithelium of fish, as is the case in all other vertebrates, is of the simple columnar type, and is built up of two main kinds of cells, namely, the absorptive columnar and the mucus-secreting goblet cells. However, two other varieties of cells are commonly encountered in the intestinal epithelium, in the form of lymphocytes and granular cells. The lymphocytes are vascular elements which are known to leave their haunts in the vascular system to the connective tissue and thence to epithelia to the outside. On the other hand, the granular cells are supposed to be wandering cells belonging to either the blood or connective tissue system and which, like the lymphocytes, reach various epithelia. Their fate and probable functions were described in previous papers (Al-Hussaini, 1945, 1946, 1947, 1949 *a* and *b*).

Apart from the foregoing cellular elements, certain cells have been found in the intestinal epithelium of some fish. These cells are described as pear-shaped, and have so far not been referred to by any previous author.

MATERIAL AND METHODS

The material used for study comprises three species of the Cyprinidae : *Cyprinus carpio* L., *Gobio gobio* (L.) and *Rutilus rutilus* (L.). Several methods

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for fixing and staining the epithelium were found necessary. Bouin's and Zenker's fixatives followed by staining in Delafield's haematoxylin and eosin were used. M.A.S. of Baker (1942) was also used as a fixative followed by Heidenhain's haematoxylin. Masson's trichrome stain was also employed. Tests for mucus were carried out by mucicarmine and McManus (1946) oxidation by periodic acid followed by Schiff's reagent, and for zymogen by Bowie's and Bensley's methods (cf. Lee, 1950).

Champy-Kull's method following fixation in Dietrich-Parat (cf. Volkonsky, 1928) for demonstrating mitochondria, and Kolatschew's and Nassanow's methods for the Golgi apparatus were used.

To evoke mitosis the intestinal epithelium was mechanichally stimulated by scratching it with a pin in a live fish and then examining it 24 hours afterwards.

OBSERVATIONS

The number of pear-shaped cells is variable; in some cases several of them may be seen in one fold while in others they may be very scarce. However, this variation is not connected with the feeding condition of the fish. The cells are quite probably not all homologous in the three species, but rather appear to fall into two different categories : one occurring in *Gobio* and *Cyprinus* and the other in *Rutilus*. The first type includes cells of the size corresponding with that of the swollen portion of the goblet cells. They show interesting cytological features. With some techniques, as for instance with Bouin's or Zenker's fixation followed by haematoxylin staining, the structure of the cell appears to be quite simple, showing a spheroidal nucleus lying at the base of the cell and a clear cytoplasm containing faintly stained threads or rods extending from the nucleus to the pointed end of the cell. With mitochondrial techniques the rods are well demonstrated, staining heavily with acid fuchsin. They are two to four in number in *Gobeo* (fig. 1) and of an elliptical shape; in *Cyprinus* they are more numerous (8-9) but much thinner. Each rod has one or more thickenings or nodules along its middle portion (figs. 1 and 2). Careful examination under oil-immersion reveals the presence of a narrow stoma by means



Fig. 1. — Photomicrograph of two pear-shaped cells in the intestinal epithelium of *Gobio gobio*.
F., Dietrich-Parat; S., Kull. X 1600.

of which the cell communicates with the lumen of the intestine. With Heidenhain's staining following M.A.S. of Baker the cell inclusions are well demonstrated, staining brownish black. They appear shorter than with the mitochondrial technique, but their nodules appear thicker, probably due to the swelling action of the acetic acid in the fixative. In some cases the cytoplasmic contents stain lightly with mucicarmine but intensely with light green of Masson's trichrome stain as well as pink with Schiff's reaction after McManus; in other cases the nodules only stain with light green and the rest of the cell is negative to mucicarmine. The cells are negative to the zymogen tests.

The cells show a well developed Golgi apparatus much larger than that of the absorptive cell disposed between the nucleus and the pointed end of the cell (fig. 3).

Only in *Cyprinus* did I notice mitotic figures in these cells. During cell division (fig. 2) the chromatine of the nucleus migrates into the centre of the cell leaving the nuclear membrane behind, and this ultimately disappears. The spindle is formed at right angles to the longitudinal axis of the cell, and after nuclear division a cleft is developed at the base

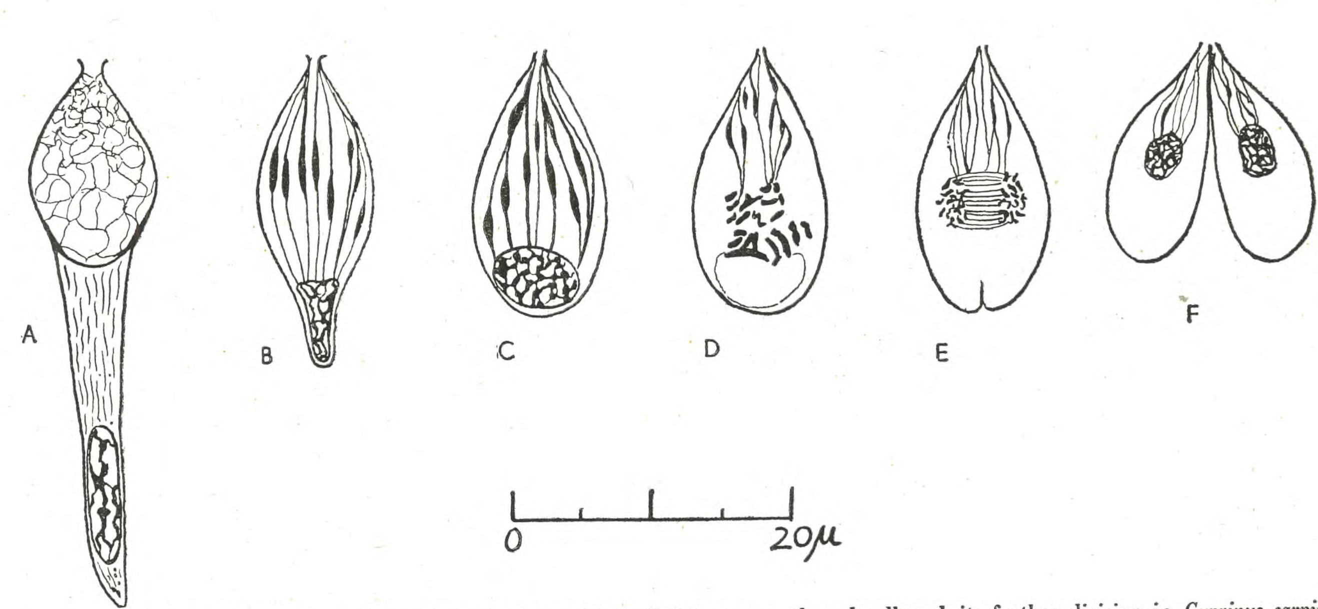


Fig. 2. — Drawing of the stages of modification of a goblet cell into a pear-shaped cell and its further division in *Cyprinus carpio*. *a,* goblet cell; *b,* withdrawal of nucleus and formation of rods and nodules; *c,* disappearance of basal process; *d,* metaphase; *e,* telophase; *f,* two daughter cells.

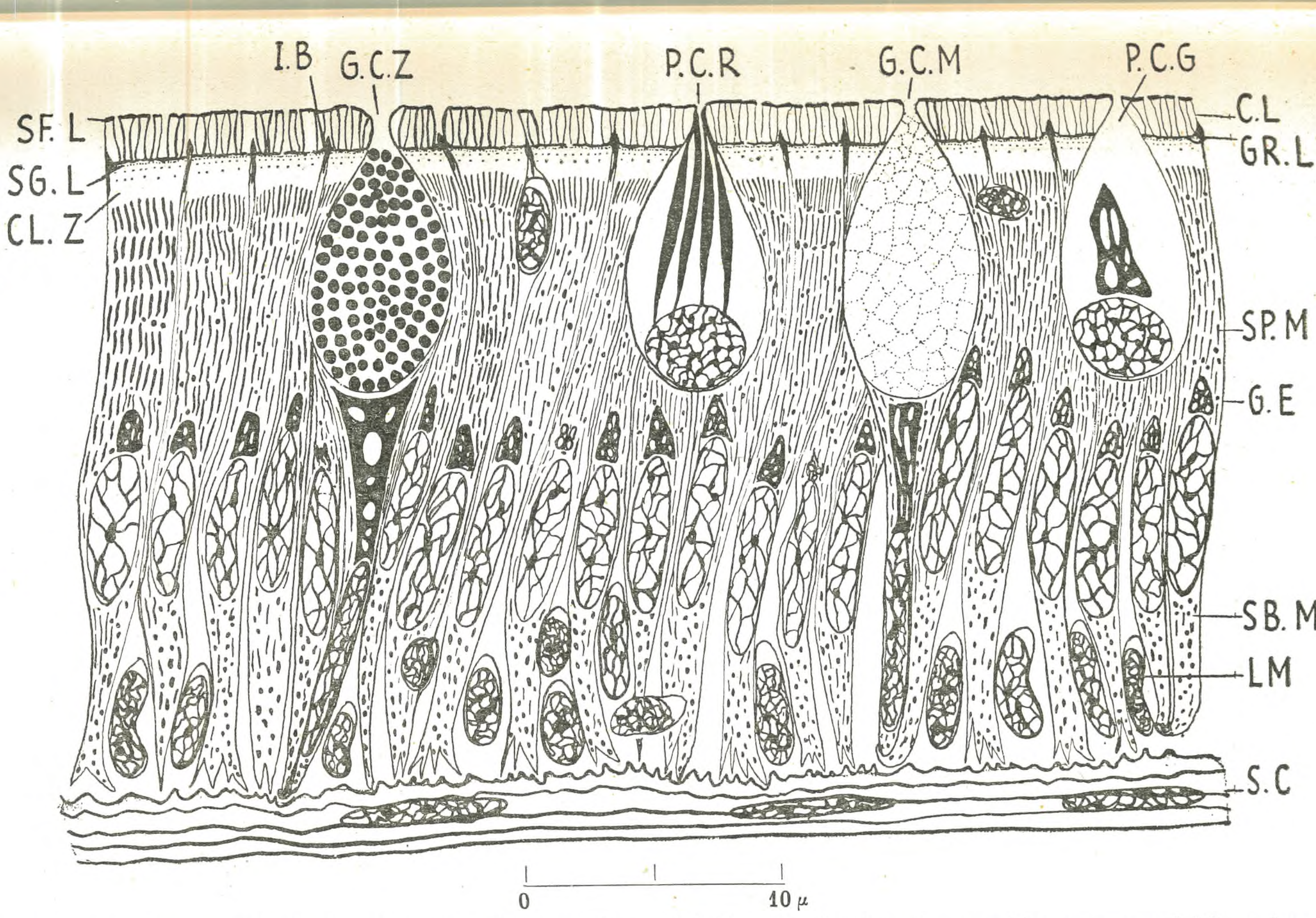


Fig. 3. — A 'composite' drawing of the intestinal epithelium of *Gobio gobio* showing the cytoarchitecture as revealed by various techniques.
c.l., canal layer; cl.z., clear zone of cytoplasm; g.c.m., goblet cell showing mucus; g.c.z., goblet cell showing zymogen; G.e., Golgi element; gr.l., granular layer; lm., lymphocyte; sg.l., subgranular layer; sb.m., subnuclear group of mitochondria; sf.l., superficial layer; sp.m., supranuclear group of mitochondria; s.c., stratum compactum; p.c.g., pear-shaped cell showing Golgi element; p.c.r., pear-shaped cell showing rods.

of the cell body which finally extends upwards longitudinally, giving rise to two daughter cells. Division occurs only in the bases of the epithelium, never at the sides of the folds if the cells happen to reach these sites, and thus conforms to the behaviour of the other epithelial cell types.

In a specimen of *Gobeo,* the rectal epithelium was mechanically stimulated and examined 24 hours later. It was observed in this experimental fish that there were numerous pear-shaped cells attached by their pointed ends to the free border. Each cell had small bodies in the middle, stained darkly with Delafield's haematoxylin; each body was surrounded by an area stained pale blue. With Heidenhain's haematoxylin, however, the bodies appear stained as one dark mass filling up a great part of the cell; thus this mass is largely chromatin in nature. The cell resembles the neighbouring goblet cells in many respects except that it does not stain with mucicarmine and that it does not possess the tail-like process which houses the nucleus and which is characteristic of the goblet cell. It would appear therefore that the mechanical strain caused the disintegration of the nucleus of the goblet cell, the remains of which then passed into the swollen portion of the cell, thus artificially producing a pear-shaped cell. Of course the difference between the latter and the normal pear-shaped cell is that the intact nucleus lies at the bottom and not in the middle of the normal cell.

The artificially produced pear-shaped cells gave a clue to their origin in both normal and experimental fish. Intermediate stages between the goblet cell and the pear-shaped cell were found, although, it must be admitted, they are quite rare. At one stage (fig. 2 *b*) the basal process was much constricted and the nucleus was squeezed, appearing biconcave. At this stage the rods and their nodules are well developed and it seems possible that the action of these rods is to pull the nucleus into the base of the swollen portion of the cell. This traction continues until, as noticed in *Cyprinus,* the nucleus reaches the central region where there is room for division. Once this has been accomplished the rods diminish and the nodules attached dwindle, but do not entirely disappear.

The fact that the rods stain with acid fuchsin with the mitochondrial techniques throws some light on their possible origin and suggests

that they may be mitochondrial in nature. It may be that mitochondria fuse to form rods. Rare examples of mitochondria fusing together are known in the animal tissues (in the spermatozoa for instance). In *Gobio* where mitochondria are coarse, the rods are well developed; while in *Cyprinus* where these organoids are much finer, the rods too are thinner but more numerous.

The Golgi apparatus (or element as it is sometimes called) is driven in front of the nucleus as the latter is pulled by the rods into the chalice and if, as suggested above, they represent the multiplication stage of a goblet cell it would explain why they have a well developed Golgi element, comparable to that of the goblet cell. It is suggested that the nodules attached to the rods are probably derived from mucus which has very likely changed its chemical structure and hardened giving at first a positive reaction with all mucus stains but later failing to stain with mucicarmine.

In *Cyprinus,* however, it was not possible to find any stage that could be definitely regarded as subsequent to cell division and which would show the daughter cells becoming modified into goblet cells again and resuming their original activity. It is difficult, however, to accept the idea that goblet cells in *Cyprinus* multiply in this manner since some of the undifferentiated cells at the base of the folds deposit mucus and very likely, as shown in a previous paper (Al-Hussaini, 1949 *b*), the progenitors of the goblet cells, a view more in agreement with the state of affairs found in the rest of vertebrates. In this case, the behaviour of the goblet cells described above and the series of modifications they undergo remain unexplained. It may be postulated that a goblet cell in these two fishes (*Cyprinus carpio* and *Gobio gobio*) may lose its ability to produce mucus and zymogen and then become modified in this curious manner to be shed later when it reaches the crest of a fold. Division of the pear-shaped cell of *Cyprinus* might well be stimulated by the same conditions that stimulate the surrounding cells — that is the cells at the base of the folds — to divide. Finally, it is possible that while the goblet cells are formed from undifferentiated cells at the base of the folds (cf. Al-Hussaini, 1949 *b*) some of the now specialised goblet cells may nevertheless retain their capacity for cell division for

a longer or shorter period after specialisation, in which case they would divide in the manner described above.

None of the workers on the cyprinid gut (such as Valatour, 1861; Edinger, 1877; Pictet, 1909; Rogick, 1931; Curry, 1939 etc.) has referred to the type of cell in question. However, it is interesting to refer in this connexion to Macklin and Macklin (1932) who found that in chronic inflammatory conditions of the intestinal mucosa of mammals the goblet cells may be so increased as to appear to be the only epithelial cells present that « one must conclude that .... goblet cells developed by multiplication from those present at the beginning of the inflammatory process». Of the authors who, according to Macklin and Macklin, have seen mitotic figures in the goblet cells are Sacerdotti (1894) and Schaffer (1922).

In *Rutilus* the pear-shaped cells are much smaller in size than those found in the other two types. They also contain few granules which are sometimes lengthened at both ends. The cells are found at various levels of the epithelium and their pointed ends are always directed towards the lumen of the intestine. A difference between this type and that encountered in *Cyprinus* and *Gobio* is that the cells in *Rutilus* do not possess a stoma. Similar cells are found in the pancreatic tissue as well as in the mesenteries suggesting that they are a migratory type of cell. The structures nearest to them described in literature are those referred to by Duthie (1939). This author described how in marine teleosts the granular cells — originating from the blood — undergo modification when they invade the epithelium; the granules become elongated and the cell becomes pointed at the end nearer to the lumen of the intestine. He stressed his conception about modification of the granules by saying that « this is a definite functional phenomenon possibly determined by the age of the cell, and almost certainly representing a discharge of the granules on to the surface of the epithelium». Objections to Duthie's conception lie in the fact that while the granular cells in the intestinal epithelium as figured by him (cf. his figure, plate II, fig. 6) have a greater number of granules than those found in pear-shaped cells of *Rutilus,* they are nevertheless far fewer than those found in the granular cells of the submucosal connective tissue. Duthie did not remark upon the fact that the granules of the granular cells he described become fewer in number. Furthermore, in many species granular cells are encountered close to the free border which resemble, in almost every respect, granular cells lying, either at the base of the epithelium, or in the connective tissue, except that in some cases the cell is ruptured as though emitting its contents (cf. Al-Hussaini, 1946, fig. 6); in other words the granular cells in the epithelium do not necessarily undergo appreciable modification as Duthie described.

It appears quite probable that the pear-shaped cells of the second type, as represented in *Rutilus,* are derivatives of some cellular structures originally found either in the blood or in the connective tissue, which, due to their wandering activities, may reach certain surfaces such as the intestinal epithelium, mesenteries or pancreatic alveoli. In this respect they show wandering activities comparable to the lymphocytes.

SUMMARY

Pear-shaped cells have been encountered in the intestinal epithelium of three cyprinid fishes : *Cyprinus carpio, Gobio gobio* and *Rutilus rutilus,* and described for the first time.

Experimental evidence indicates possible origin from the goblet cells of the pear-shaped cells in *Cyprinus* and *Gobio.* Intermediate stages between the pear-shaped cells and goblet-cells have been observed. In *Cyprinus* the pear-shaped cell divides mitotically. Available evidence seems to support the view that pear-shaped cells do in fact represent a form of cell division which mature goblet cells may undergo.

The pear-shaped cells in *Rutilus* are derived from some wandering blood or connective tissue cell.

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NOTICE NÉCROLOGIQUE
SUR
MARCEL JUNGFLEISCH[1]

PAR
PAUL BALOG

Après une longue et pénible maladie, un grand savant français vient de disparaître. Tous nous connaissons bien la silhouette de ce confrère au maintien modeste, mais dont le regard pétillait d'intelligence et de vie. Son physique était marqué par trois quarts de siècle de dur labeur et de sacrifice continu, alors que son esprit, demeuré jeune, était plein d'ardeur pour la science qu'il ne cessa de servir.

Marcel Clément Léon Jungfleisch est né à Paris le 14 février 1879 d'une ancienne famille alsacienne depuis longtemps devenue française. Il fit ses études à Paris, puis entra à l'Institut national d'agronomie. Son intérêt pour le monde arabe semble dater de cette époque, car, après l'obtention de son diplôme d'ingénieur agronome en 1899, il alla passer un été en Tunisie. Puis, son service militaire accompli, il s'embarqua pour l'Egypte, où il se fixa définitivement en 1902. Elle fut sa seconde patrie.

Marcel Jungfleisch commença sa carrière en Egypte en 1902 comme chef des cultures aux Sucreries de Nag Hammadi. En 1912, l'Agricultural Bank of Egypt lui confie la direction d'une de ses agences en Haute-Egypte, et, en 1927, il entre au service du Crédit Foncier au Caire. Atteint par la limite d'âge en 1947, il prend sa retraite pour se consacrer entièrement à la numismatique.

Sa formation humaniste et surtout ses dispositions ont très tôt éveillé en lui un intérêt intense pour l'histoire ancienne. Mais ce sont les

[1] Notice présentée en séance du 1er décembre 1958.

circonstances qui le poussèrent définitivement vers la numismatique. Au début du siècle, quand Marcel Jungfleisch s'établit en Haute-Egypte, le fellah ne disposait pas encore d'engrais chimique pour l'amélioration du sol : il se servait, à l'instar de ses ancêtres, depuis de longs siècles, des briques crues provenant d'agglomérations de l'Antiquité et du Moyen Âge : le fameux «sebakh» connu de tous les archéologues.

Avec cette exploitation continuelle des sites anciens, en quête de l'engrais naturel, se laissait déterrer une masse de menus objets anciens que le fellah offrait au premier preneur. Grâce à sa présence sur les lieux, Jungfleisch acquit un flot de monnaies.

Il était naturel qu'un esprit aussi fertile et aussi curieux se mît à étudier un trésor aussi varié. Pour ce faire, il s'initia à plusieurs secteurs de la numismatique ancienne, et devint rapidement une autorité dans la connaissance des monnaies gréco-romaines, byzantines et surtout musulmanes.

Dès 1925, M. Jungfleisch commença à publier des articles dont chacun est un témoignage de son érudition, de l'acuité de son observation et de l'exactitude de ses recherches. Une intuition sûre l'a souvent amené à faire des découvertes très importantes qui n'ont pas tardé à lui assurer une solide renommée. Très rapidement, il fut admis au sein des principales sociétés de numismatique et fut élu, dès 1927, membre correspondant de l'Institut d'Egypte.

Après avoir publié un travail sur *la restauration des monnaies anciennes* et un autre sur *une formule nouvelle figurant sur les monnaies mamelouks,* il fit une découverte importante consignée dans son article intitulé *Un poids fatimite en plomb.* Son mérite est d'autant plus grand que le matériel dont il a tiré ses conclusions brillantes consistait en une seule rondelle de plomb dont il n'existait pas d'autre exemplaire pour comparaison. Non seulement l'objet ne portait pas d'indication de sa nature, en tant que poids, mais il appartenait aussi à une catégorie totalement ignorée jusque-là. Peu de temps après : *Poids fatimites commerciaux en verre,* autre précieuse découverte ; puis la description d'*un poids fort abbasside en verre rarissime, intact,* contribution importante à la métrologie musulmane.

Le *catalogue des déneraux et estampilles byzantins en verre de la collection Froehner,* publié en 1932, nous présente un côté nouveau de la compétence de Jungfleisch. Nous devons signaler, à cette occasion, sa découverte des *poids monétaires en verre byzantino-arabes,* faite en 1946, mais dérivée de l'étude qui avait donné naissance au *catalogue.*

De tels mérites scientifiques furent récompensés par plusieurs décorations françaises et étrangères, et, en 1944, par l'élection de Marcel Jungfleisch au rang de membre titulaire de l'Institut d'Egypte. Cet homme industrieux comme une abeille, aux habitudes d'une extrême simplicité, ascète, n'épargnait pour la science ni dépenses ni fatigues. Quand il ne faisait pas sa tournée régulière chez les antiquaires, on pouvait le trouver à toute heure attablé à son bureau, rédigeant ses fiches, admirablement tenues, ou bien, la loupe à la main, en train d'étudier ses chères monnaies jusqu'à une heure avancée de la nuit.

Les recherches de ses dernières années couronnent bien son activité. En 1948 il découvrit les *documents métrologiques de la dynastie toulounide* jusqu'alors inconnus, ainsi que des *monnaies de grand format du sultan mamelouk Hadjy II,* ayant servi probablement comme étalons de poids. Comme s'il voulait montrer les multiples facettes de son talent, Jungfleisch donna plusieurs articles sur les *trouvailles de monnaies grecques provenant d'Egypte.* Une de ses publications d'alors, sur l'*attribution des solidi byzantins à certains ateliers grâce à la présence de lettres isolées sur ces monnaies,* fut particulièrement appréciée.

Aussi la Société américaine de Numismatique l'a-t-elle élue parmi ses membres correspondants, honneur rarement octroyé.

D'une santé chancelante et quasi octogénaire, Marcel Jungfleisch n'en continua pas moins à travailler, à communiquer les résultats de ses vastes recherches : ses *Poids forts en verre antéislamiques* révèlent l'existence de documents pondéraux jusqu'alors insoupçonnés, ses *Conquêtes du Midi* font connaître les monnaies turques émises à l'occasion de l'expansion de l'empire ottoman sous Sélim Ier, pour ne mentionner que ces deux-là d'une longue série.

La numismatique, si accaparante qu'elle fût, n'empêcha pas Marcel Jungfleisch de consacrer un nombre extraordinaire de publications à des sujets d'agronomie. Pour une cinquantaine d'études de numismatique, il est l'auteur d'environ cent quarante travaux sur l'agriculture. Si utiles que soient ces derniers, c'est sa magistrale contribution à la

numismatique et à la métrologie qui lui assurera un nom dans la postérité.

Depuis deux ans, la santé de Marcel Jungfleisch baissait petit à petit; parfois une amélioration temporaire lui accordait quelque répit : mais malgré les efforts de ses médecins et amis, il s'est éteint le 12 mars 1958.

D'un caractère généreux en toutes circonstances, gentilhomme intègre, sévère envers lui-même et indulgent envers ses amis, auxquels il vouait une fidélité absolue, il sut gagner l'estime et l'amitié de tous ceux qui l'approchèrent.

La numismatique, dont il fut un pilier, lui reconnaît une place d'honneur; nous, ses amis, le garderons fidèlement dans notre mémoire.

THE DISPERSION OF BIREFRINGENCE IN MINERALS AND THE APPARENT WIDTH OF THE ISOGYRE[1]

BY

SALAMA TOSSON

INTRODUCTION and ACKNOWLEDGEMENTS

The phenomenon of the dispersion of birefringence long ago attracted the interest of authors.

Klein, Hlawatsch, Ehringhaus studied certain minerals with abnormal interference colours due to a strong dispersion of birefringence.

Ehringhaus introduced a numerical value « N » which should give an indication of the type and strength of the dispersion of birefringence.

F. Penta in 1933 showed that the number of Ehringhaus does not satisfy the request in all cases. He proposed a new quotient to express the different cases more efficiently.

In the present paper these different symbols are discussed and new numerical values that possibly satisfy the various conditions are introduced.

In optically uniaxial crystals, the quantity and the quality of the dispersion of birefringence depends only on the dispersion of the principal indices of refraction. The type of the dispersion varies with direction in the latter, but is constant in the former. In monoclinic and triclinic crystals it depends furthermore, on the variable position of the indicatrix for different wave lengths. The interdependence of all these factors therefore has to be studied.

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[1] Communications présentée en séance du 12 janvier 1959.

However the aim of the present paper is not to undertake a theoretical discussion of higher optics but to ascertain the observability of the effects of the dispersion of the birefringence in the practical routine work of mineralogists and petrographers on the polarising microscope.

The conditions of visibility of the abnormal interference colours due to dispersion of an optic axis, and the limits of the applicability of the chromatic compensation method are examined.

Sincere gratitude to Prof. Dr. A. Rittmann for the valuable discussion and assistance accorded the author.

I. THE DISPERSION OF BIREFRINGENCE AND ITS DIFFERENT TYPES.

The dispersion, in a wide sense, is the variation in value of the optical constants, or in position of definite optical directions for different colours of the spectrum. Amorphous substances and isometric crystals have one type of dispersion, namely, that of the index of refraction.

In optically uniaxial crystals the dispersion of refraction of the ordinary ray (n_o) may be different from that of the extraordinary one (n_e). This inequality of the dispersion of the indices produces a dispersion of the birefringence. The type of dispersion of birefringence remains strictly the same for any direction of observation.

In optically biaxial crystals all three principal indices of refraction may have widely different dispersions, and consequently the dispersion of birefringence may also exist. In this case, however, the type of the dispersion of birefringence varies with the direction of observation. This variation is great, especially in the neighbourhood of dispersed optic axes. In any case the variation of the dispersion of birefringence is related to the dispersion of the optic axes and to that of the ellispoidal axes of the indicatrices if they are ever present.

Table (1) shows the various possible dispersions in the different crystal systems.

The possible types of the dispersion of birefringence are tabulated below (Table 2), and illustrated in figures 1 and 2.

TABLE 1.

Crystal System	n	B	A	B_1	B_2	B_3
Cubic and Amorphous	+	—	—	—	—	—
Tetragonal and Hexagonal	+	+	—	—	—	—
Orthorhombic (symmetrical)	+	+	+	—	—	—
Monoclinic :						
1. $B_1 = b$	+	+	+	—	+	+
2. $B_2 = b$	+	+	+	+	—	+
3. $B_3 = b$	+	+	+	+	+	—
Triclinic (Assymetric)............	+	+	+	+	+	+

n = The refraction.

B = The birefringence.

A = The optic axes.

B_1, B_2, B_3 are consequently the acute, the obtuse bisectrices, and the optic normal.

b = The crystallographic b-axis.

$B_1 = b$ is crossed dispersion.

$B_2 = b$ is horizontal dispersion.

$B_3 = b$ is inclined dispersion.

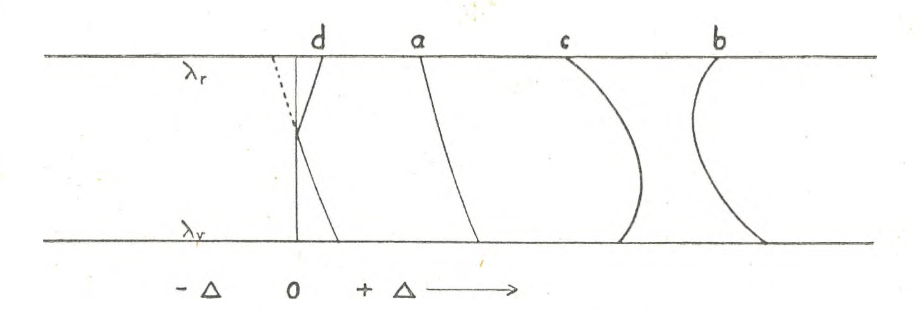


FIG. 1.— The case of $B_r < B_v$ (the birefringence for red is smaller than that for violet) illustrated with varieties *a, b, c, d.*

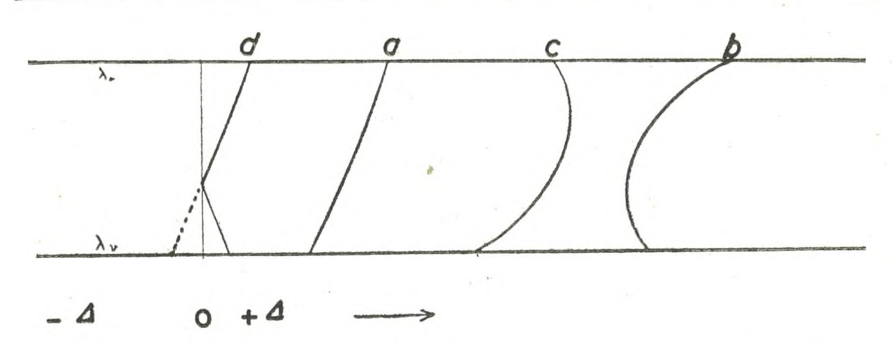


FIG. 2. — The case of $B_r > B_v$ (the birefringence for red is greater than that for violet) illustrated with varieties *a, b, c, d.*

TABLE 2.

1. $B_r < B_v$	2. $B_r > B_v$
(*a*) $B_r < B_\lambda < B_v$	(*a*) $B_r > B_\lambda > B_v$
(*b*) $B_\lambda < B_r$ (minimum)	(*b*) $B_\lambda < B_v$ (minimum)
(*c*) $B_\lambda > B_v$ (maximum)	(*c*) $B_\lambda > B_v$ (maximum)
(*d*) $B_\lambda = 0$	(*d*) $B_\lambda = 0$

In the case $B_\lambda=0$ the sign of the birefringence for red (B_r) is opposite that of the birefringence for violet (B_v).

The birefringence considered in the table and figures are absolute values [B], the true ones are indicated in the figure in dotted lines.

THE NUMBER OF EHRINGHAUS «N» AND THE QUOTIENT « $\frac{a}{b}$ » OF PENTA.

The Ehringhaus number « N » is quantitative expression for the degree of the relative dispersion of birefringence. It is equal to the birefringence for D light ($\lambda_D = 589\mu\mu$) over the difference of the birefringence for the C and F light ($\lambda_C = 656\mu\mu$ and $\lambda_F = 486\mu\mu$).

$$N = \frac{B_D}{B_C - B_F}$$

This number « N » is useful for comparing the dispersion of different crystallized substances. It is positive in sign if the birefringence in red is greater than in blue, and vice versa.



If we have no dispersion the value of the number « N » is infinity. In the special case, when the birefringence in D light is equal to Zero, the « N » value is Zero, whatever the values of the birefringence in red and in violet.

The expression is well applied if the dispersion of birefringence is a linear function of the wave length, or nearly so. But it was found that a rather large number of substances show minima or maxima values for intermediate wave lengths. In these cases the Ehringhaus number is not suitable as illustrated by Penta in 1933.

Penta (1933) made studies on the mineral epidote and discussed the limit of the use of the value « N » of Ehringhaus. He found that in epidote the dispersion is not a linear function of the wave length in the visible part of spectrum, but that it shows a minimum value for wave length of about $530\mu\mu$. He mentioned in the same paper that the phenomena of minima and maxima in the dispersion of birefringence of minerals is more common than is generally believed.

If the number N of Ehringhaus is used to express the dispersion of birefringence of a mineral as epidote with a minimum value it will show it as a mineral of low or already no dispersion, although in reality it has a strong dispersion, as can be established by a number of measurements in different monochromatic lights.

Penta (1933) proposed that if one wishes to indicate the type of an anamoly by means of a few measurements (only 3)—exists not more than one minimum or maximum—one should substitute the number of Ehringhaus by an index of the following type :

$$\frac{B_G - B_{\text{minimum or maximum}}}{B_B - B_{\text{minimum or maximum}}}$$

where B_G=the birefringence at G light of wave length of $430\mu\mu$.
B_B=the birefringence in B light of the wave length of $685\mu\mu$.

These indices take the form of a quotient kept as numerator and denominator. It does not give a numerical value.

It must be noted that the numbers appearing in Penta's quotient are absolute values of the dispersion of birefringence in the visible spectrum or in parts of it. On the contrary the Ehringhaus number gives

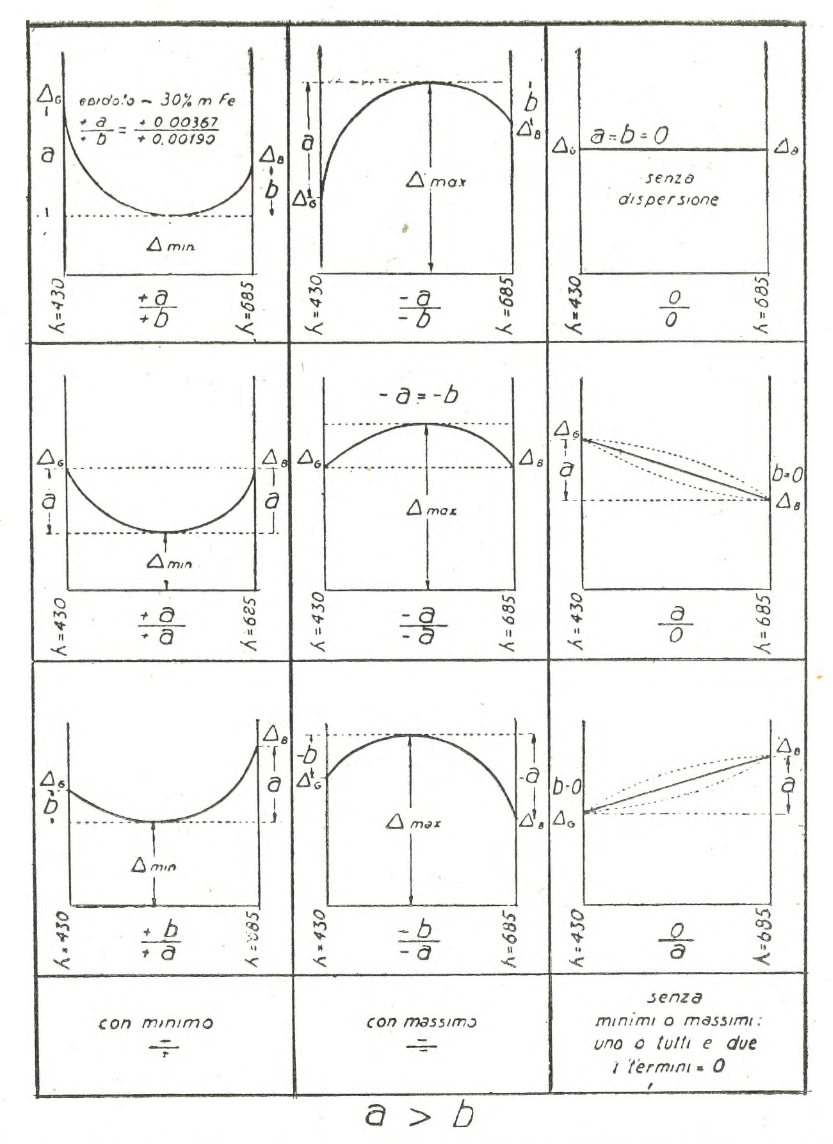


Fig. 3. — Table of the 9 principal cases of the birefringence as a function of the wave length (after Penta 1933).
The first column is for minima cases.
The second column is for maxima cases.
The third column is for no maxima or minima.
Δ_G = the birefringence at G line of wave length = 430$\mu\mu$.
Δ_B = the birefringence at B line of wave length = 685$\mu\mu$.
$a = \Delta_G - \Delta$ minimum or maximum.
$b = \Delta_B - \Delta$ minimum or maximum.
$a > b$.

reciprocal relative values of the dispersion of birefringence referred to B_λ equals to that at D light.

Using such a « Penta quotient» one substitutes the curve by a couple of straight lines, and in the case of the absence of minimum or maximum, by one straight line, not taking in account the curvature in figure 3 (see the nine cases represented by Penta, published in 1933).

For comparison, the 8 cases mentioned in figures 1 and 2 are represented in the form of Penta quotient and the Ehringhaus number, as follows :

Table 3.

Case	Ehringhaus	Penta
No dispersion of birefringence . . .	infinity	$\frac{0}{0}$
1 *a*	negative	$\frac{+a}{0}$
1 *b*	»	$\frac{+b}{+b}$
1 *c*	»	$\frac{-b}{-a}$
1 *d*	»	$\frac{+a}{+b}$
2 *a*	positive	$\frac{0}{+a}$
2 *b*	»	$\frac{+b}{+a}$
2 *c*	»	$\frac{-a}{-b}$
2 *d*	»	$\frac{+b}{+a}$

II. THE INTERFERENCE COLOURS.

Ehringhaus in his paper published in 1920 mentioned that two crystals with different average birefringence show identical sequences of interference colours if their retardation curves can be brought to coincide by proportional variation of their ordinates.

In his own words : « Zwei Kristalle mit verschieden starker mittlerer Doppelbrechung besitzen dann identische Farbfolgen, wenn ihre Gangunterschieds-Kurven durch proportionale Aenderung der Ordinaten vollständig zur Deckung gebracht werden können.» In other words, two minerals of different birefringence show the same type of interference colours if their relative dispersion of birefringence are equal. This is the reason why Ehringhaus introduced the N value as a numerical expression for the visible effect of the dispersion of birefringence.

The normal sequence of the interference colours exists only where there is a weak or no relative dispersion in the mineral. In the presence of stronger dispersion this sequence is changed. The following table shows the classification of interference colours according to the variation of dispersion, using the Ehringhaus number to indicate this variation.

The Introduction of a New Symbol for the Dispersion of Birefringence

From table 3 it is clear that the Ehringhaus number N distinguishes only part one from part two, but not *a, b, c, d,* cases from each other. In other words, it does not deal with the cases of minima or maxima.

The Penta quotient allows further distinction especially for maxima and minima cases but it gives no indication if we have to deal with the cases *b* or *d*. In these cases we may get the same Penta symbol although the dispersion is different.

Physiologically, the visible effect of the dispersion of birefringence is expressed numerically by the Ehringhaus number which compares the type of interference colours, while the Penta quotient gives no relation to the abnormality of interference colours.

Table 4.

Type of dispersion	Range of EHRINGHAUS number N	Type of interference colour	Examples
(1) None or slight	+ 30 to ∞ to — 30	normal	quartz, gypsum etc.
(2) $B_r > B_v$	+ 3.46 to + 30	subnormal	brucite, some zoisites, augite sanidine, sometimes zircon.
(3) $B_r \gg B_v$	+ 0.68 to + 3.46	antinormal	apophylite.
(4) $B_r \mp B_v$ .... $B_\lambda = 0$	— 1.76 to 0 to + 0.68	abnormal	penninite, clinochlore, vesuvianite.
(5) $B_r < B_v$	— 30 to — 1.76	supernormal	clinoziosite, tourmaline, epidote, etc.

see figures 1 and 2.

Such disadvantages of the symbols of Ehringhaus and Penta, attracted the attention of the author and encouraged him to develop a new symbol that possibly satisfies the different cases.

The dispersion of birefringence can be expressed by two separate numbers, say S and T.

$$S = \frac{B_C - B_D}{B_D} \quad \text{and} \quad T = \frac{B_D - B_F}{B_D}$$

Fig. 4.

Fig. 4. — The birefringence B is drawn as ordinate against the wave length as absisca, at C, D and F lines.
The values S and T are shown.

where B_C=the birefringence in the C light of wave length $656\mu\mu$.

B_D=the birefringence in the D light (sodium light) of wave length $589\mu\mu$.

and B_F=the birefringence in the F light of wave length $486\mu\mu$.

The values S and T are related to the number N of Ehringhaus, as follows :

If we draw, as in figure 4, the birefringence as ordinate against the wave length as absisca, we get :

$$\frac{1}{N} = \frac{B_C - B_F}{B_D} \qquad \text{see figure 4}$$

$$S = \frac{B_C - B_D}{B_D} \quad \text{and} \quad T = \frac{B_D - B_F}{B_D}$$

$$\text{hence} \quad \frac{1}{N} = A + B$$

Under the condition that the dispersion of birefringence is a linear function of the wave length we have furthermore

$$\frac{\lambda_C - \lambda_D}{\lambda_D - \lambda_F} = \frac{67}{103} \simeq \frac{2}{3}$$

From this it follows immediately

$$S = \frac{2}{5N} = 0.4\,\frac{1}{N} \qquad \left(\text{exactly } 0.394\,\frac{1}{N}\right)$$

$$T = \frac{3}{5N} = 0.6\,\frac{1}{N} \qquad \left(\text{exactly } 0.606\,\frac{1}{N}\right)$$

Under the mentioned condition if we know N we can therefore get the values S and T.

The following table gives the value N for the different types of dispersion and their corresponding S and T values.

If the dispersion is a linear function of the wave length, as in Table 5, the values S and T are positive in sign if $B_r > B_v$, while they are negative if $B_r < B_v$. They have the same sign as the number of Ehringhaus.

Table 5.

Type of interference colours	N	$\frac{1}{N}$	S	T
	infinity	0	0	0
Normal				
	+ 30.0	+ 0.033	+ 0.013	+ 0.020
Subnormal				
	+ 3.46	+ 0.28	+ 0.112	+ 0.168
Antinormal..........				
	+ 0.68	+ 1.47	+ 0.588	+ 0.882
Abnormal				
	— 1.76	— 0.57	— 0.228	— 0.342
Supernormal				
	— 30.0	— 0.033	— 0.013	— 0.020
Normal				
	infinity	0	0	0

But, as has already been mentioned, the dispersion of birefringence is never exactly a linear function of the wave length and may even show minima and maxima in the visible spectrum, so we can summarize the relations between S, T and the dispersion of the above cases in the following :

1. If there is a minimum in the more visible part of the spectrum, the value S is positive in sign, while T is negative.

2. If there is a maximum in the more visible part of the spectrum, value S is negative in sign and T is positive.

3. If one of S or T is normal while the other is not, the character of the interference colours is that of the latter.

4. If neither S nor T is normal and no maxima or minima exist, the character of the resulting interference colours will correspond to the stronger anomaly.

The values S and T are useful in comparing the different types of the dispersion of birefringence. They have the following advantages :

1. They are intimately related to the number N of Ehringhaus. Knowing the values S and T the number N can be calculated.

2. The symbol is simple since it consists of two figures S and T, which in contrast to the Penta quotient always have the same physical meaning.

3. They are based only on three determinations of birefringence in different wave lengths of light in the clearly visible part of the spectrum, without measuring the whole curve of dispersion.

4. They immediately show the main features of the curve of dispersion as the sign of inclination, the sense of curvature and the existence of extreme value as marked maxima or minima.

5. They express the relative dispersion of birefringence in numerical value.

6. They allow the determination of the kind of the resulting interference colours.

To illustrate the interdependence of the absolute values of the dispersion of birefringence, the relative dispersion numerically expressed in N, S, T values and the type of interference colours, a practical example of the mineral augite is considered.

The following data of the mineral augite (reported in Rosenbusch-Wulfing : Mikroskopische Physiographie der gesteinsbildenden Mineralien, part II, p. 480) is used.

TABLE 6.

Spectral line	n_p	n_m	n_g	B	2V	c/n_g
C	1.6943	1.7006	1.7188	0.0245	61° 33'	+ 44° 37'
D	1.6975	1.7039	1.7227	0.0252	61° 12'	+ 44° 53'
F	1.7075	1.7138	1.7330	0.0255	60° 9'	+ 45° 18'

If the dispersion is calculated at the two optic axes A' and A'' using the above table it can be clearly seen that the dispersion at the first optic axis is noticeable and has no maximum or minimum, while at the second optic axis it is weak and has a maximum in the visible part of the spectrum. This is shown by the angles c/A' and c/A'' given in table 7.

TABLE 7.

Spectral line	c/A'	c/A''
C	13° 50.5'	75° 23.5'
D	14° 17'	75° 29'
F	15° 13.5'	75° 22.5'
The optic axis dispersion	1° 23'	0° 6.5'

c = The crystallographic c axis.

The values of the birefringences for the directions around the optic axes, in the optic axial plane, were calculated by substituting the values given in table 6 in the following formula :

$$B' = n_m - \frac{1}{\frac{\cos^2\rho}{n_g^2} + \frac{\sin^2\rho}{n_p^2}}$$

where ρ is the angle between the direction of the partial birefringence B' and the acute bisectrix n_g.

As in this treatment the requirement is the dispersion of birefringence *i. e.* the difference between the birefringences; so the values of birefringences were therefore calculated till the 5th decimal for F, D, and C light for about 30 positions of birefringence around the optic axes.

In figures 5 and 6 the absolute values of the dispersion of birefringence are drawn against the wave lengths for F, D, and C light for a series of Z position of 2° intervals, where $Z°$ is the angle between the direction at which the birefringence is calculated and the crystallographic *c*-axis. The values of birefringence at D light are plotted to coincide with the corresponding Z values.

In figures 7 and 8 the values $\frac{1}{N}$ and S, T are drawn for a range of 20° in a direction around the first optic axis (at $Z=14° 17'$ for D light).

Figures 9 and 10 represent the $\frac{1}{N}$ and S, T values for a range of 20° in the optic axial plane around the second optic axis (at $Z=75° 29'$ for D light).

In figure 5 the curves show that the dispersion of birefringence is strong. On the side of the *c*-axis the birefringence for red is smaller than for violet but beyond the optic axis the birefringence for red becomes greater than for violet.

Figure 6 shows the curves of the absolute dispersion of birefringence around the second optic axis in the direction of the optic axial plane. The curves indicate that the dispersion around this optic axis is weak, the contrary to the curve of figure 7. The curves towards the acute bisectrix show maximum values of birefringence in the visible part of the spectrum, with the birefringence for red greater than that for violet.

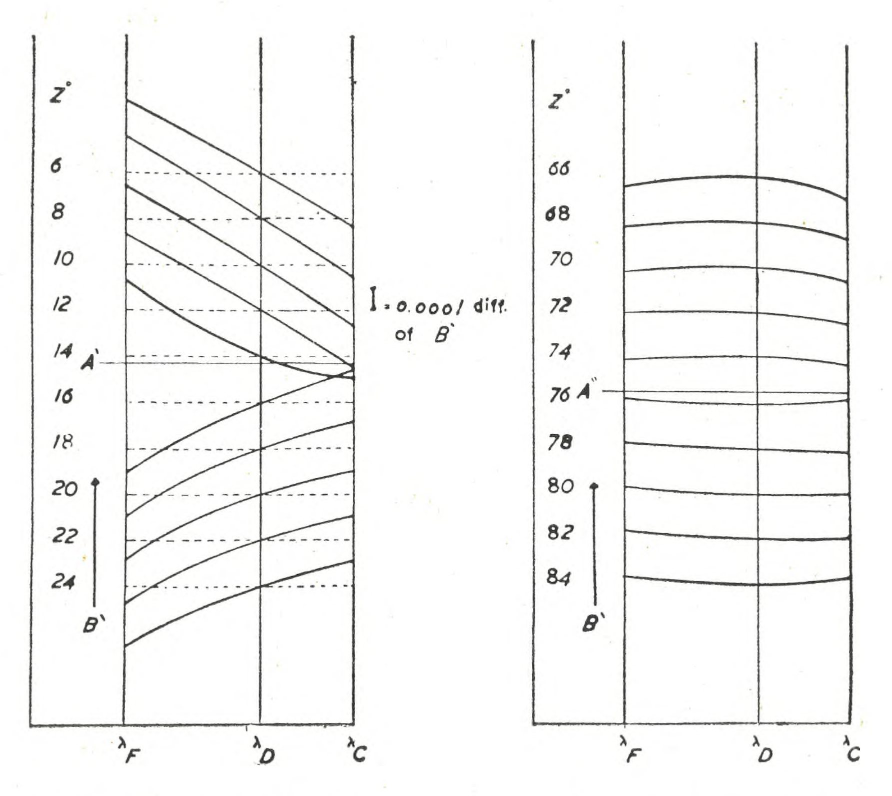


Fig. 5. — The curves of the dispersion at positions of Z around the first optic axis of strong dispersion.

Fig. 6. — The curves of the dispersion at positions of Z around the second optic axis of weak dispersion.

The value of the birefringence drawn against the wave length as absisca for C, D, and F light, for the mineral augite. Z=the angle between the direction at which the birefringence is calculated and the crystallographic *c*-axis.
B' =the partial birefringence calculated at C, D and F light.

On the other side of the optic axis, the dispersion is still weak or negligible but we have minimum values of birefringence instead of maximum ones.

It is interesting to note that in figures 5 and 6 the absolute values of the dispersion of birefringence varies very little in the whole range.

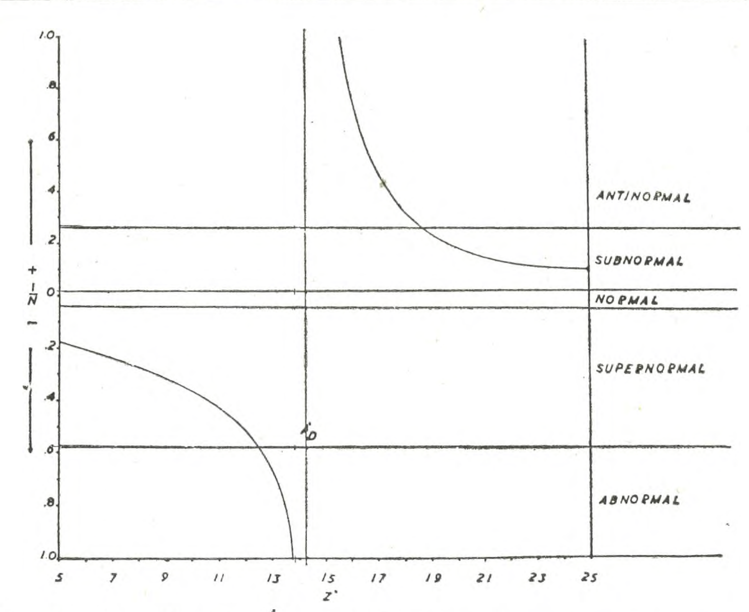


Fig. 7. — The value $\frac{1}{N}$ as ordinate with positive and negative sign. The value of Z in degrees as absisca, around the first optic axis of augite.

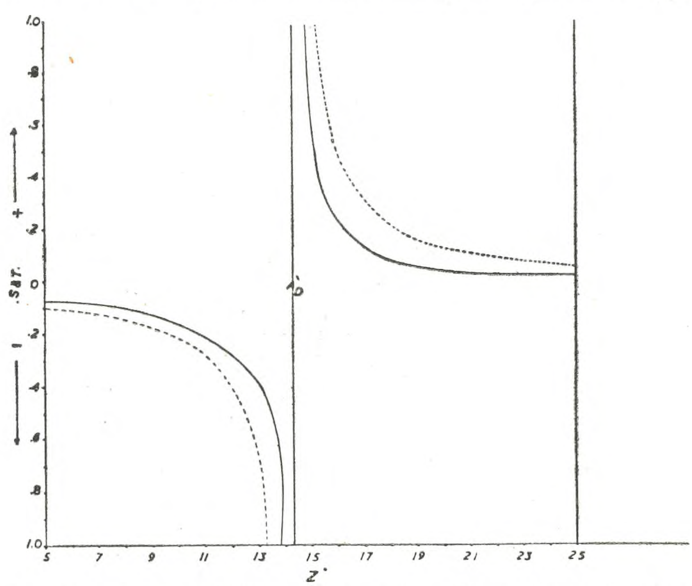


Fig. 8. — The value S and T as ordinate with positive and negative sign, and the value of Z in degrees as absisca, around the first optic axis of augite.
S = —— full lines.
T = ---- dotted lines.
A'_D = The first optic axis in D light.

Figure 7 represents the dispersion around the first optic axis in $\frac{1}{N}$ values. Contrary to figure 5, as the representation here is in $\frac{1}{N}$ values *i. e.* since the dispersion is considered in relative values, they indicate the change of interference colours. Notwithstanding the fact that change in the absolute dispersion given in figure 5 is nearly constant, the relative dispersion in figure 7 shows considerable variation in the interference colours. From $Z=5$ till about 12.5 the colours are supernormal, then from 12.5 to about 15 abnormal colours exist. From 15 to 18.5 the colours become antinormal, and above 18.5 they are subnormal.

Towards the acute bisectrix the dispersion of birefringence decreases rapidly and in the direction of the acute bisectrix $\frac{1}{N}$ equals zero and S=-0.016 and T=+0.016, so that the interference colours become normal.

Figure 8 represents the relative dispersion around the same optic axis but in S and T values. The curves show as in figure 7 that on one side of the optic axis the curve is positive (the birefringence for red is greater than for violet) while on the other side it is opposite and negative in sign, (*i. e.* the birefringence for red is smaller than for violet).

But the S and T values show, furthermore, that between $Z=5$ to 10 the dispersion must be nearly a linear function of the wave length, because S is about 2/3 T. At $Z=14$ the values S=-0.7 and T=-2.6 were found. S is here negative and much smaller than 2/3 T, and the dispersion curve must be strongly concave. Beyond the optic axis the values of S and T are positive, S being again smaller that 2/3 T, the dispersion curve must be convex.

Figure 9 represents the relative dispersion around the second optic axis in $\frac{1}{N}$ values. It shows as in figure 6 that $\frac{1}{N}$ is nearly enclosed in the zero region, *i. e.* shows weak dispersion. But as there is minima and maxima, the representation is not quite indicative for the sense of curvature. At $Z=74°$, for example, it shows supernormal interference colours although it is in reality in part supernormal and in the other subnormal. This is clearly shown in figure 10 with S, T values, in which it becomes noticeable that in one part S the curve is negative (*i. e.* the birefringence for red is smaller than for violet) while the other part T,

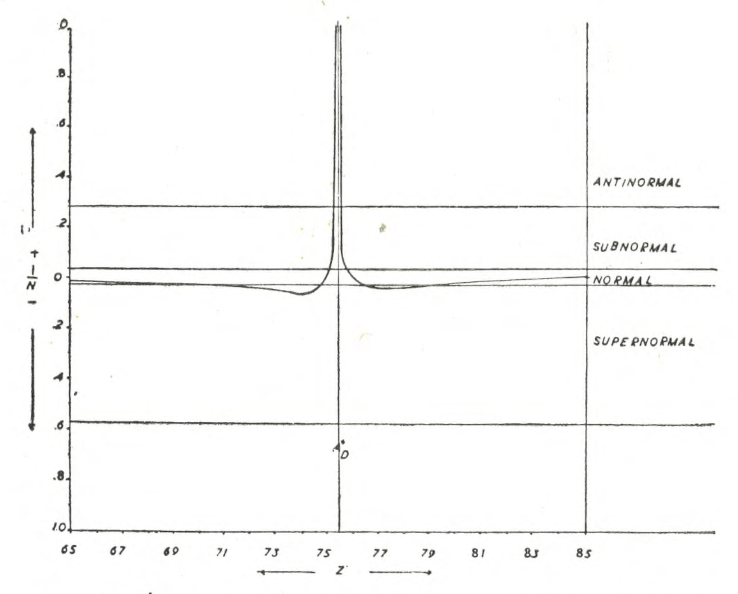


FIG. 9.— The value $\frac{1}{N}$ as ordinate with positive and negative sign, and the value of Z in degrees as absisca (around the second optic axis of augite).

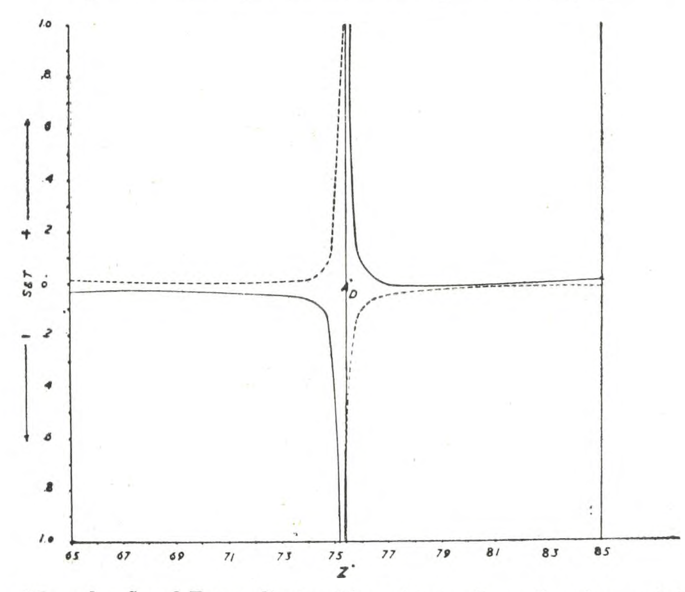


FIG. 10.— The value S and T as ordinate with positive and negative sign, and the value Z in degrees as absisca (around the second optic axis).
S = ‿ full lines.
T = ---- dotted lines.
A_D = The second optic axis in D light.
Z° is the same as in figures 6 and 7.

it is positive (*i.e* . the birefringence for violet is smaller than for red), and as illustrated in the curve in figure 7.

The representation in S and T expresses the behavior of the dispersion in the visible part of the spectrum showing minima, maxima, sense of curvature etc., much better than the number N of Ehringhaus.

The Dispersion of Birefringence of the Compensating Material

The well known compensators, as those of Babinet, Wright, Berek, Ehringhaus, etc., have as compensating materials quartz, calcite and muscovite. These compensator materials show normal interference colours and are considered to have negligible dispersion. But in reality they have a weak dispersion of birefringence, which must be considered if we are to deal with problems of dispersion.

Quartz for example shows slight dispersion with the birefringence in red smaller than in violet as shown in table 8 and 9.

From these tables it follows that for quartz
$R_C : R_D : R_F$ is as 0.991 : 1 : 1.021
S=-0.020, T=-0.009, $\frac{1}{N}$=-0.029
and N=-34.5.

The calcite used in the Berek compensator also shows a birefringence in red smaller than in violet, as shown in table 10. The ratio of the retardations in C, D and F lights is : -0.986 : 1 : 1.030.
i. e. S =-0.030 , T=-0.013
and hence, $\frac{1}{N}$ =-0.043 , N=-23.3

The above values of S, T indicate that in calcite the birefringence in red is smaller than in violet especially towards the long waves of the spectrum.

As the compensators are generally graduated for D light, the values mentioned in the last tables allow for correction of the determined retardations for C and F light.

In figure 11 published by Penta (1933) for epidote, the curve number 3 gives the dispersion of epidote without correction for the compensating material, while curve number 1 is drawn after correcting the error due to dispersion of the compensating material. The difference between the two curves is too great to be neglected.

TABLE 8 (quartz) [1].

Wave length	$n_e - n_o$	Wave length	$n_e - n_o$
4000	0.0095454	5200	0.0092097
4200	0.0094706	5400	0.0091731
4400	0.0094049	5600	0.0091403
4600	0.0093471	5800	0.0091108
4800	0.0092958	6000	0.0090839
5000	0.0092502	6200	0.0090595

[1] Table for the birefringence of quartz with different wave lengths of light (measured by DE LEPINAY and reported by P. NIGGLI in « Lehrbuch der Mineralogie » part 1 in 1924).
The wave length is expressed in 10^{-8} cms.

TABLE 9 (quartz).

The index of refraction	C	D	F
n_o	1.55093	1.55336	1.55898
n_e	1.54190	1.54425	1.54968
B	0.00903	0.00911	0.00930

TABLE 10 (calcite).

The index of refraction	C	D	F
n_o	1.6544	1.6584	1.6679
n_e	1.4857	1.4864	1.4907
B	0.1697	0.1720	0.1772

B = the birefringence given in C, D, and F lights.

Tables 9 and 10 are reported by N. Winchell in « Elements of optical mineralogy» Part II in 1933.

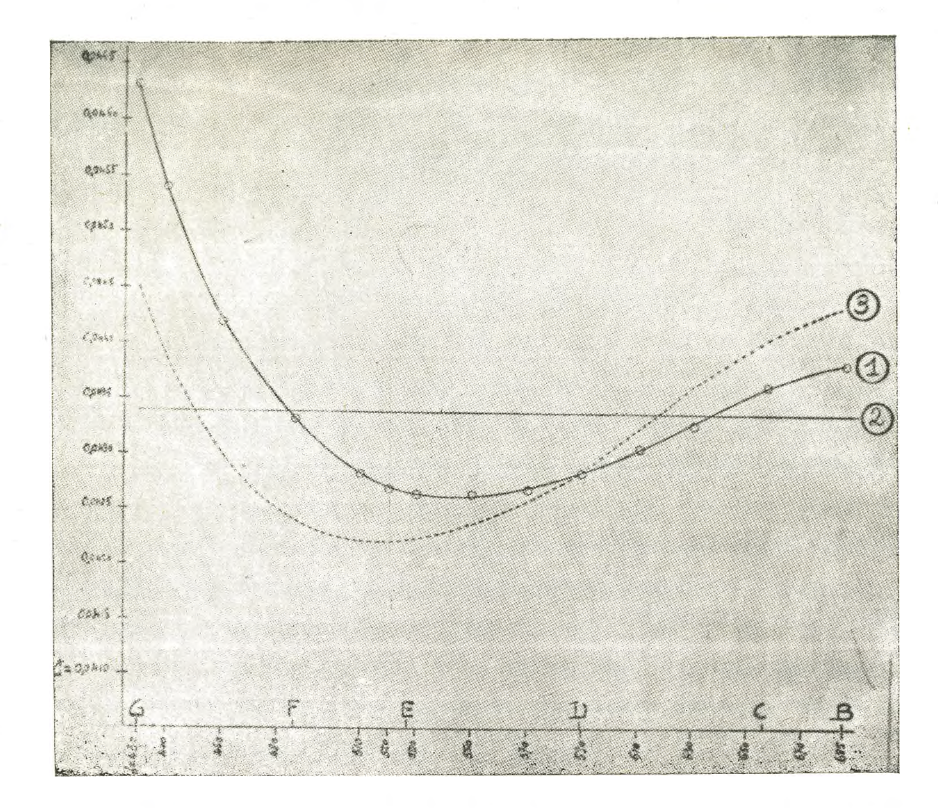


FIG. 11.— Figure published by Penta (1933) showing the effect of the compensator material and how it changes the curve of dispersion if taken into consideration.

1. A curve of the maximum birefringence against the wave length, for epidote with 30% iron content.
2. Shows the average maximum birefringence.
3. A curve of the maximum birefringence, of the same epidote, as a function of the wave length without considering the effect of the dispersion of the material of the Berek compensator (calcite),

absisca = Wave length in $\mu\mu$.
ordinate = birefringence.

Relation Between the Dispersion of Birefringence and other Types of Dispersion

Since we are treating a problem of dispersion it was found relevant to discuss some relations of dispersion under different conditions or assumptions. Let us ask, what are the conditions under which there is no dispersion of the optic axial angle (2V)?

This happens if :

$$\frac{n_{pr}}{n_{pv}} = \frac{n_{mr}}{n_{mv}} = \frac{n_{gr}}{n_{gv}} \qquad \text{.................. (1)}$$

where n_{pr} & n_{pv}=the lowest refractive index for red and violet.
n_{mr} and n_{mv}=the medium refractive index for red and violet.
n_{gr} and n_{gv}=the highest refractive index for red and violet.

Equation 1 can be written in another form :

$$\frac{n_p}{k.n_p} = \frac{n_m}{k.n_m} = \frac{n_g}{k.n_g}$$

where k is a constant.

Applying equation 1 we get :

$$\tan^2 V_r = \frac{\dfrac{1}{n_p^2} - \dfrac{1}{n_m^2}}{\dfrac{1}{n_m^2} - \dfrac{1}{n_g^2}}$$

which is evidently equal to $\tan^2 V_v$ for violet.

This equality shows that under the condition expressed by equation (1), the optic axial angle does not change with variation of the wave length of light. It is clear that under this condition the dispersion of birefringence exists and is of the same type in all directions, although there is no dispersion of 2V.

The second question that may arise is: what are the conditions under which there is no dispersion of birefringence, and what is the dispersion of the optic axial angle in such a case?

This takes place if :

$$n_{pr} - n_{pv} = n_{mr} - n_{mv} = n_{gr} - n_{gv}$$

namely $n_p - (n_p + k) = n_m - (n_m + k) = n_g - (n_g + k)$

From this it immediately follows that $\tan^2 V$ (for violet) is not equal to $\tan^2 V$ (for red).

This inequality means that there is dispersion of the optic axial angle although there is no dispersion of birefringence.

From the above discussions it is clear that the case of no dispersion of both the optic axial angle and the birefringence is only possible, theoretically, if there is no dispersion of the indices. But it is known that a substance that shows no dispersion of indices does not exist.

In other words, it can be assumed that all crystallized substances generally show both the dispersion of birefringence and the dispersion of the optic axial angle, with the exception of the above two cases which are extremely improbable.

The previous discussions are applicable in the case of orthorhombic minerals, *i. e.* those with symmetrical dispersion. In monoclinic and triclinic minerals it becomes more complicated. In monoclinic minerals, for example, we have crossed, horizontal and inclined dispersion (table 1). The symmetry becomes different from one optic axis to the other. This is illustrated by the example titanaugite mentioned before. In this monoclinic augite we have one optic axis clearly dispersed while the other is very weakly dispersed. In figures 5, 6, 7, 9, and 8, 10 of the two optic axes the symmetry is lacking.

In orthorhombic minerals, on the other hand, this variation in the dispersion from one optic axis to the other does not exist. The symmetry is not disturbed by the change of position.

III. THE APPARENT WIDTH AND THE DISPERSION OF ISOGYRE.

Theory and explanations.

The phenomenon of dispersion of optic axis and the colouration of isogyres was noticed a long time ago, and mentioned in the text books of optics.

In some cases the isogyres are completely coloured, as in minerals with strong dispersion, e. g. titanite. In other cases of weaker dispersion the colouration is generally limited to the borders of the isogyre. In the majority of minerals the isogyre is black or with no marginal colouration, and it is said that there is no visible dispersion.

In order to discuss the limits of the visibility it was found pertinent to mention the relation between the thickness of isogyre, its colouration and the dispersion of the axis.

In an interference figure with a centered optic axis, the isogyre has, in monochromatic light, a certain width that may be termed L and which can be expressed in degrees (see figure 12).

$L = x + y$ where x is the angular distance from the centre of the isogyre to the border towards the acute bisectrix, and y is the angular

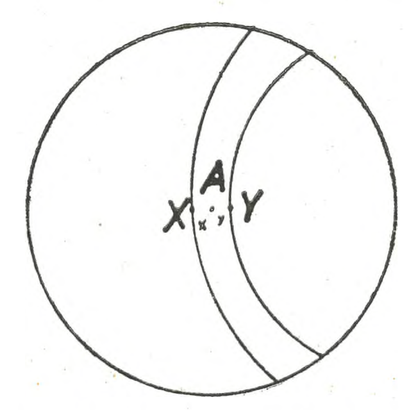


Fig. 12.— The isogyre in the diagonal position.
A = the trace of the optic axis.
$x + y$ = the width of the isogyre.

distance from the centre of the isogyre (A) to its border towards the obtuse bisectrix.

Let us consider the case of no dispersion of the optic axis : the L at point (A) should be infinitely small. But practically it may correspond to some degrees, because, the neighbouring zones of extremely low retardations are so dark grey that they seem to make part of the isogyre.

The interesting problem to be resolved is the determination of the apparent width for different values of the optical axial angle, the birefringence and the thickness.

The problem can be resolved graphically :
we have $B' = \sin \alpha' \ \sin \alpha'' \ B$.
in which α' and α'' are the angles between the direction of the partial birefringence B' and the optic axes A' and A'' consecutively and B the maximum birefringence.
So $B_x = \sin x \sin (2V - x) B$.
where B_x is the birefringence at the point x.
similarly $B_y = \sin y . \sin (2V + y) . B$.
Further :

$$R_x = \frac{d . B_x}{\cos_x} \quad \text{and}$$

$$R_y = \frac{d . B_y}{\cos_y}$$

Where R_x and R_y are retardations in the directions x and y.
If 2V equals zero (uniaxial) x loses its significance and is substituted by y, we have therefore :

$$R_y = \frac{d . B . \sin^2 y}{\cos y}$$

If 2V greater than zero (biaxial) we have :

$$R_x = d.B.\tan x . \sin (2V - x). \quad \text{and}$$

$$R_y = d.B.\tan y . \sin (2V + y).$$

where d = the thickness of the section perpendicular to the optic axis.
and B = the maximum birefringence of the mineral.
If we have the value x or y in degrees, and 2V, d, B (maximum) are known, we can ascertain R_x or R_y.

Figure (13) is drawn by plotting x and y as absisca, against $\frac{R_x}{d.B}$ as ordinate. For unification the B maximum was considered to be 100, at unit thickness. The corresponding values of x were calculated for the following values of 2V : 0°, 10°, 20°, 30°, 40°, 50°, 70°, 90°, for x and y at intervals of 2 degrees (and at shorter intervals when it was necessary to have auxiliary points to complete the curves).

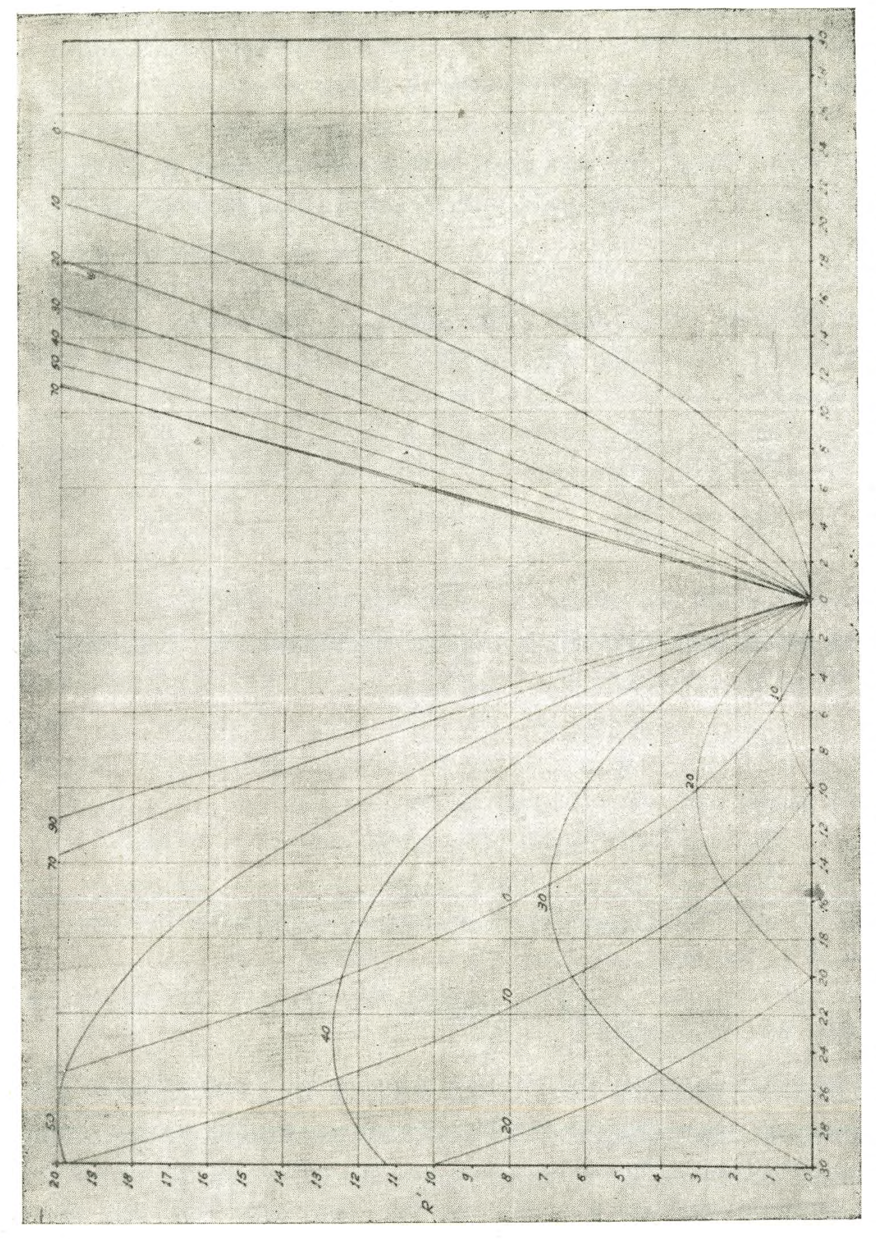


Fig. 13. — A diagram showing the change of the relative retardations R' for B = 100 and d = 1, as function of x and y for various optic axial angles (2 V).

The second figure (14) was drawn with x and y as absisca and 2V as ordinate, of curves for the values of *d*.B. : 100, 200, 500, 1000, 5000, for $R_x = R_y = 15\mu\mu$ (the apparent borders of the isogyre under favourable conditions, see the practical part later).

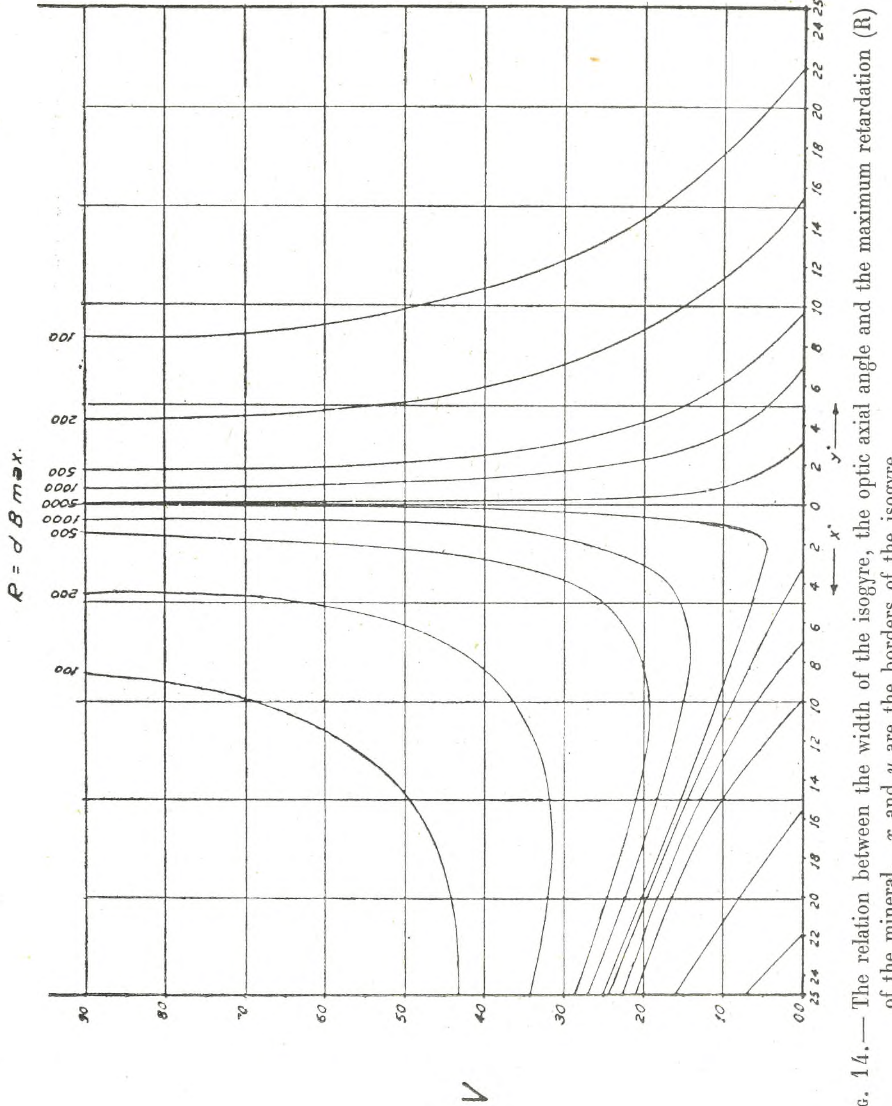


Fig. 14. — The relation between the width of the isogyre, the optic axial angle and the maximum retardation (R) of the mineral. x and y are the borders of the isogyre.

Example : A mineral of an optic axial angle 30° and a maximum retardation $500\mu\mu$ would have x = 4° and y = 3° *i.e.* the apparent width L = 7°.

The figure shows clearly that at high retardation ($5000\mu\mu$) the isogyre becomes very thin.

Such diagram shows the variation of the width of the isogyre $x + y$ with the retardation of the mineral, and its optic axial angle.

The well known fact that the isogyre becomes sharper with increasing birefringence and thickness is demonstrated quantitatively in this diagram.

Furthermore, the diagram explains the quantitative relation between the apparent width (L) of the isogyre and the angle 2V; L becoming smaller with increasing 2V (see the example mentioned with figure 14).

The above calculations refer to monochromatic light. If we consider white light and a very strong dispersion of the axis (D_A), (figure 15), we see in the diagonal position a completely coloured isogyre. This

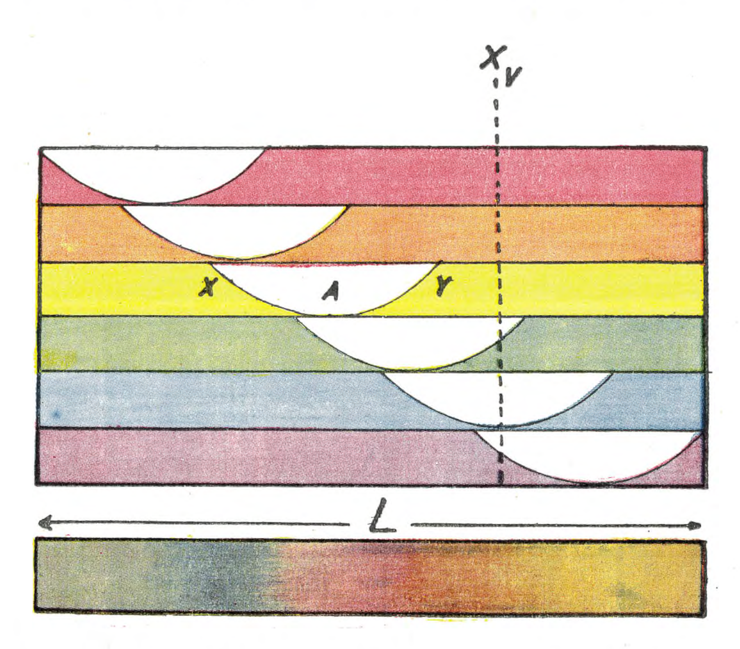


Fig. 15. — Illustration of a case of very strong dispersion of axis and high maximum retardation (d.B.).
The isogyre appears completely coloured but wide.
At X_v : yellow, orange, and red pass completly while blue is eliminated, green and violet are strongly reduced.
The resulting colour is bright reddish orange.
L = the width of the isogyre in white light.
$x + y$ = the width of the isogyre for a definite wave length.
A = the optic axis for yellow light.

shows a sequence of abnormal interference colours that are complementary to those colours of the spectrum for which the birefringence is zero (provided that the dispersion of the axis does not change its sense in the visible part of the spectrum). The apparent width L is the angular distance between the extreme coloured borders of the isogyre.

Let us suppose that the border lines for the isogyre R_r (for red) $= 15\mu\mu$, and, R_v (for violet) $= 15\mu\mu$, and we have :

$$L = L_o + D_A = (x + y) + D_A$$

In the case of strong dispersion and great retardation *d*.B, the value of L_o is nearly equal to zero, and the relation will be :

$$D_A \gg (x + y) = (L - D_A) = L_o$$

This relation is explained by figure (15), showing the arrangement of the complementary colours to give at the end a coloured isogyre, each point of which is the result of the combination of a group of colours. At the point X_v for example (see figure 15) yellow, orange, and red pass completely, while blue is eliminated, green and violet are strongly reduced.

The resulting colour is a bright reddish orange. In the case of weak dispersion (see figure 16), we see a blackish (grey) isogyre with faintly coloured borders in bluish green, and brownish yellow.

The relation in this case will be :

$$D_A \ll (x + y) = \text{approximately } L - D_A$$

The coloured borders are hardly visible. At X_v (see fig. 16) violet passes while the other colours are increasingly reduced towards the central part of the spectrum.

Therefore, at X_v in this case there results a bluish grey, rather indistinct mixture of complementary colours (see figure 16).

But for the same mineral in a thick section *i.e.* with high retardation (*d*.B.) the coloured borders become clear (see figure 17), and the thickness of the isogyre decreases as it is nearly inversely proportional to the retardation (see figure 14).

In this case the relation will be :

$$D_A \text{ is greater than } (x + y) = \text{approximately } L - D_A$$

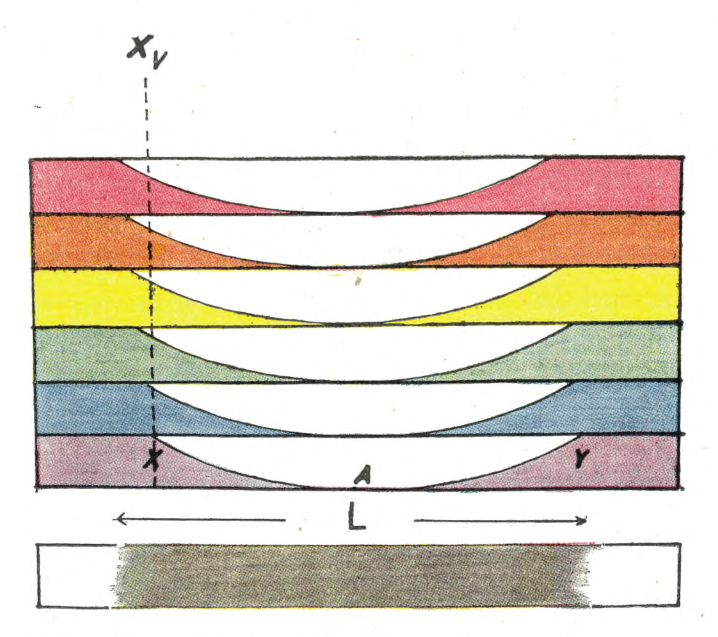


Fig. 16. — The case of weak dispersion of an optic axis with low retardation. The isogyre appears blackish with thin coloured borders.
At X_v : violet passes while the other colours are increasingly reduced toward the central part of the spectrum, so at X_v results a bluish gray, rather indistinct mixture of complementary colours.

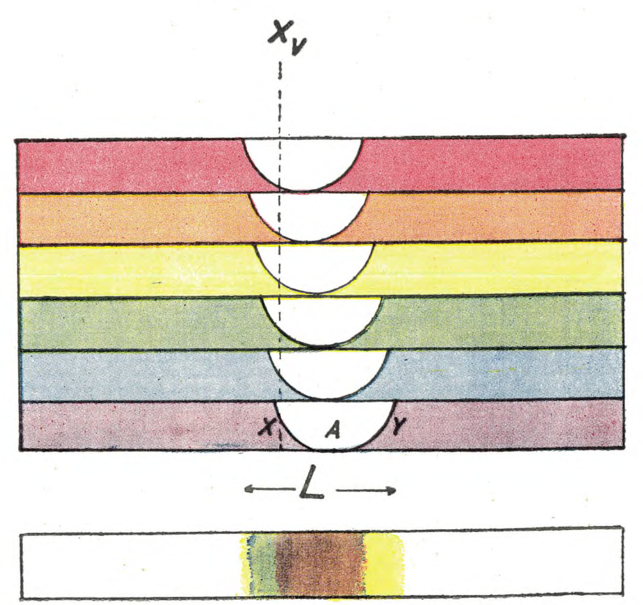


Fig. 17. — The case of weak dispersion as in fig. 16, but with high retardation. The isogyre appears narrower and completely coloured.
At X_v : violet passes while the other colours are reduced rapidly with increasing wave length, and red is almost extinct. The resultant colour is a distinct rather bright bluish green one.

At the point X_v (see figure 17) the red is almost completely eliminated, while the other colours pass with increasing intensity towards the violet side. The resultant colour is a distinct rather bright bluish-green one.

The same dispersion of the axis, which in a thin section was hardly visible, is therefore strikingly visible in a thicker preparation that represents a higher retardation.

This phenomenon may explain why the earlier petrographers such as Zirkel, Rosenbusch, Michel-Lévy, Fouquè etc., often described dispersions of optic axes on common minerals that do not show any dispersion in our modern much thinner sections.

If the dispersion of the axis is weak no coloured borders are to be seen, notwithstanding the fact that theoretically they should exist.

This inferior limit of visibility is due to physiological factors. It has to be determined empirically using a mineral that shows a hardly visible dispersion of the axis in the conoscope. Having established this dispersion of the axis n_m, B, d, and $2V_D$ (the optic axial angle in D light) of the mineral, the limit of visibility (Q) can be calculated after getting x and y ($x + y = L_o$).

Comparing figures 15, 16 and 17 it is evident that the visibility of the dispersion of the axes depends not only upon the value of the dispersion of the axis itself, but also on the retardation ($R = d.B.$), L, and L_o (and hence, upon 2V and n_m).

Figure (18) is a representation of the apparent borders of the isogyre with red and violet.

From this figure it is clear that the limit of visibility :

$$Q = \frac{R_x + R_y}{r_x + r_y}$$

$$= \frac{\tan x \, . \, \sin (2V - x) \quad + \quad \tan y \, . \, \sin (2V + y)}{\tan (x - D_A) \, . \, \sin (2V - x + D_A) \quad + \quad \tan (y - D_A) \, . \, \sin (2V + y - D_A)}$$

This expression is practically equal to $\frac{L_o}{D_A}$ *i.e.* $\frac{L_o}{D_A} = \frac{L_o}{L - L_o}$ equals approximately Q where L is the angular distance of the borders of the isogyre directly observed.

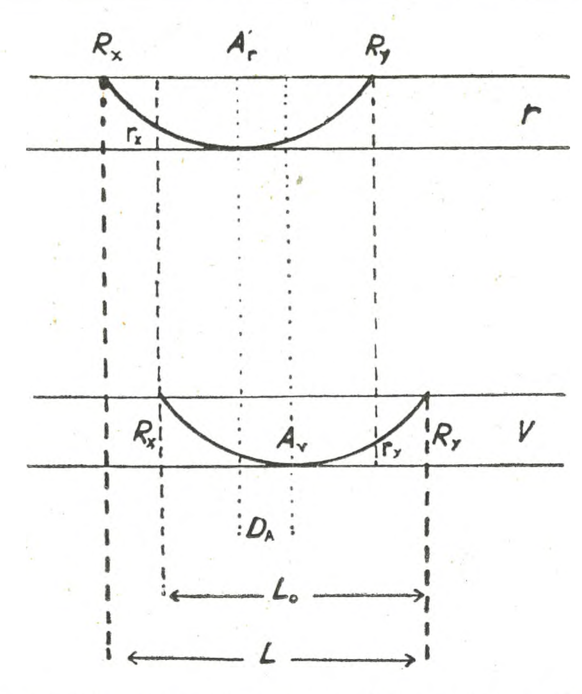


FIG. 18.— R_x and R_y = The retardation at the borders of the isogyres in red and in violet.
L_o = The width of the black part of the isogyre.
L = The width of the isogyre with coloured margins.
D_A = The dispersion of the optic axis.

L_o is calculated or read out of figure (14) after knowing the value of R and 2 V.

However, in chapter III we shall see that physiological factors interfere and complicate the use of the above relation.

PRACTICAL DETERMINATION OF R_x OR R_y

To ascertain the previous relations it is necessary to determine the value of R_x on which figure (13) is based. The value R_x is the retardation at the point x (or y), which is the apparent border of an isogyre with no dispersion.

To determine R_x or R_y, it is necessary to determine, in monochromatic light, the directions which form the angles x or y with the optic axis,

the retardations in these directions, and the value of 2V of the optic axial angle.

We have B_x = approximately $\sin x \cdot \sin (2V - x) \cdot B$ where B_x is the birefringence at the point x.

Multiplying by the thickness we get :

$R_x = \sin x \cdot \sin (2V - x) \cdot B \cdot d'$

where d' is the inclined path of light in the substance ;

i.e. $d' = \frac{d}{\cos_x}$ where d is the thickness.

Thus $R_x = \tan x \cdot \sin (2V - x) \cdot B \cdot d$

The same procedure is followed on the other side of the isogyre in the direction y and we get :

$R_y = \tan y \cdot \sin (2V + y) \cdot B \cdot d.$ (see figure 19).

R_x (or R_y) is supposed to be a constant value.

To determine the value x, a Bausch-Lomb microscope was used with Bertrand lens and an objective of aperture = 0.85. The source of light was a lamp of 35 watts, at a distance of about 10 cms. from the plane mirror of the microscope. A frosted glass pane was put in front of the lamp to get homogenous light. The whole system was installed in a dark room. The apparent thickness of the isogyre of an optic axis in the conoscopic figure was measured with a screw eye-piece micrometer.

The value x was measured in minerals showing an isogyre with no visible dispersion; the results are as follows :

Hyperthene : $x = 3° 34'$
Olivine : $x = 1° 44'$

Determination of the values 2V *and* R (d . B.) :

To substitute in the above equation to get R_x, it is necessary to determine accurately the value 2 V and R of the mineral (where R is the maximum retardation for the given thickness).

Rittmann (1946) constructed nomograms for the value of the optic axial angle, the refractive index and a value he called $Q = \frac{R_1}{R_2}$ where R_1 is the lowest and R_2 is the highest value of retardations in

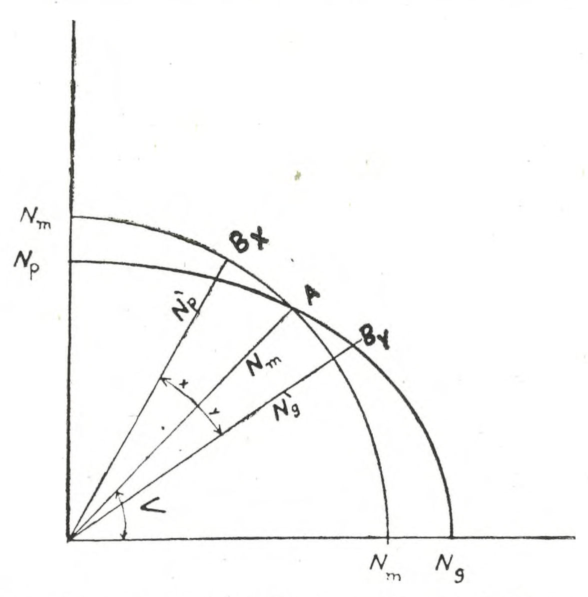


FIG. 19. — An illustration for the positions of the borders of an isogyre (x and y) with respect to the wave fronts of a biaxial mineral.

B_x and B_y = The birefringence at points x and y at the borders of the dark isogyre.

A = The centre of the isogyre.

V = The angle between A and the obtuse bisectrix.

the centered disymmetrical interference figure, at the borders of the field of view, in the diagonal position. Calculating the value of Q a sufficiently accurate value of 2 V, and the type of the interference figure, whether it is acute, obtuse or optic normal are obtained.

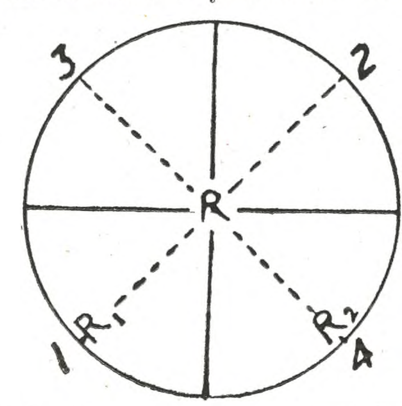


FIG. 20. — 1, 2 = Borders towards the acute bisectrix in the diagonal position. 3, 4 = Borders towards the obtuse bisectrix in the diagonal position.

To determine the values R_1 and R_2, the Berek compensator was used on a Leitz microscope with the previous conditions of illumination. The interference figure was compensated at points 1, 2, 3, and 4 (see figure 20), in the diagonal position.

The mean value of the retardation at 1 and 2 gives R_1, and the mean value of the retardation at 3 and 4 gives R_2.

The compensation at the centre of the figure gives the value of the retardation of the section.

GRADUATION OF THE BEREK COMPENSATOR

The Berek compensator was graduated in the usual way using sodium light with crossed and parallel Nicols, in order to get the positions corresponding to :

$$R = \frac{1}{2},\ 1,\ 1\frac{1}{2}\ \ldots\ldots\ \lambda D.$$

The constant of Berek is calculated using the well-known formula $\log C = \log R - \log f(i)$ (Berek 1924) where C is the constant of the Berek, and $f(i)$ is the function of the inclination.

It is noticed that the compensation for the values R_1 and R_2 is not in the centre of the field so that the constant of the Berek usually calculated in the centre cannot be used. To solve this problem the Berek was graduated for the border of the field at points 1, 2, 3, and 4, about 60 readings for each were carried out. The mean log C for 1, and 2 was found to be equal to 3.919 which is equal to the constant at the centre, while for 3 and 4 the mean log C is equal to 3.927. This difference is due to the fact that 1 and 2 are perpendicular to the rotation axis of the Berek, with the result that the average value for them is the same as at the centre, while 3 and 4 are parallel to the rotation axis of the Berek, with the result that with a curved compensation band the ends are at a different position from the centre.

PRACTICAL RESULTS

For hyperthene :

A section of hyperthene with negative optic sign was used, and the results are as follows :

$$Q = \frac{R_1}{R_2} = \frac{562.3}{691.8} = 0.813$$

From the curves we get $2V = 43°$ (this value was confirmed by direct compensation on a nearly centered conoscopic figure of an acute bisectrix), and the section is an optic normal figure with a maximum retardation of $628 \mu\mu$.

Knowing that $x = 3° 34'$ (measured above p. 40)

So $R_x = \tan x \, . \, \sin (2V - x) \, . \, B \, . \, d \; (B \, . \, d = R) = 25.9 \mu\mu$.

For olivine :

A section of olivine with the positive optic sign was used, and the results are as follows :

$Q = \frac{600}{700} = 0.86$ and so from the curves $2V = 86°$, but the section is perpendicular to the obtuse bisectrix, with a retardation of $835.6 \mu\mu$, the maximum retardation

$$R = d \, . \, B = \frac{R'}{\cos^2 v} = \frac{835.6}{\cos^2 43}$$

$x = 1° 44'$ (measured above p. 40).

so $R_x = 47.0 \mu\mu$.

N. B. :

The complete formula for the calculation of R_x was used and it gave :

R_x for hyperthene $= 29.9 \mu\mu$ and for olivine $= 57.4 \mu\mu$, *i.e.* they still show different R_x values ; this means that the difference in R_x values obtained in the above results is not due to the above abbreviated formula used, but due to practical and physiological factors, which will be discussed in the next chapter.

Observations

From the above it is clear that the value of R_x varies, although it is theoritically supposed to be a constant value. Such variation can be due to experimental and physiological conditions of observation.

However, the curves represented in figures (13, 14) explain one of the most interesting phenomena, that is the thickness of an isogyre, and how it depends on the thickness, the birefringence and the optic axial angle of the mineral in question and is of great value for the explanation of the visibility of the dispersion of the optic axis.

IV. THE CHROMATIC COMPENSATION OF THE BIREFRINGENCE

In the case of strong dispersion of birefringence the interference colours become abnormal, and can be easily distinguished from the normal ones. Such abnormal interference colours have been observed for some considerable time and used as characteristic for certain minerals. The abnormal dark blue or yellowish brown interference colours which substitute the grey of first order are known by every petrographer to be characteristic of vesuvianite, gehlenite, penninite and some other minerals. They are also very often shown in sections cut nearly perpendicular to an optic axis with strong dispersion, as for example on the strong dispersed axis of augite, on the axis of zoisite, titanite, axinite, and a great number of other minerals. Supernormal colours are characteristic of the clinozoisite-epidote series, subnormal ones of brucite, antinormal ones of many apophyllites etc.

Although these phenomena are interesting and striking, their diagnostical value is limited to a small number of minerals. Many other minerals having weaker dispersion of birefringence of the different types, show practically normal interference colours. Their weak dispersion of birefringence has no directly observable consequence. It becomes, however, noticeable during the compensation, as the compensation stripe instead of being blackish shows on both sides sequences of abnormal interference colours.

Rittmann (1947) has drawn attention to this fact and has proposed to use it for diagnostical purpose. He gave table 11, which summarizes the principal facts that may be observed during the chromatic compensation.

Before discussing the results of a series of experiments carried out in order to establish the limits of the applicability of the method of chromatic compensation, it may be useful to remind the reader of the following important facts :

1. In optically unixial crystals the type and the relative value of the dispersion of birefringence remains constant in all directions. In other

TABLE 11.

Interference Colours of the Mineral	Decreasing series of colours before compensation	Interference colours in the interval of compensation: beginning	black	end	Increasing series of colours after compensation
normal	normal		black		normal
supernormal	supernormal	bluish		reddish	subnormal
subnormal	subnormal (to leucocyclitic)	reddish		bluish	supernormal
leucocyclitic	antinormal	set of complement colours yellow, orange, red.		violet, blue, green.	strong supernormal
antinormal	antinormal	set of complement colours yellow, orange, red.		violet, blue, green.	extremely supernormal
supernormal with minimum	supernormal with minimum	complement. colour of the min.		the colour of the minimum complement.	subnormal with maximum
subnormal with maximum	subnormal with maximum	colour of the maximum complement.		colour of the max.	supernormal with minimum
abnormal with $B_{yellow} = 0$	—	colour of yellow complement.		reddish	subnormal
abnormal with $B_{blue} = 0$	—	colour of blue		bluish	supernormal

General remarks : ⟶ increasing retardation of the compensator ⟶
increasing abnormality ⟶ chromatic compensation ⟶ decreasing abnormality

words, the value of Ehringhaus' number N and of the values S and T are the same whatever may be the direction of observation.

2. On the contrary, in optically biaxial crystals, all these values are varied, sometimes in a wide range, with the direction of observation. For diagnostical purpose the chromatic compensation must, therefore, be studied on oriented sections. In thin slides these will be, especially the sections cut parallel to the optic axial plane, showing the maximum birefringence.

Studying crushed minerals or loose sands the same orientation will be used in the case of minerals without good cleavage planes. In the case of cleavable minerals, flat lying cleavage flakes will be used, as they always show a definite optical orientation on a given cleavage plane.

3. As the difference of retardations for various wave lengths increases proportionally to the thickness of a given crystal lying on a certain face, the visibility of the chromatic compensation similarly increases proportionally to the thickness.

4. Furthermore, the compensators are constructed of quartz or calcite, both minerals possess a slight dispersion of birefringence, which is greater for violet than for red. Compensating quartz by quartz, or calcite by calcite, the compensation will be reached at the same time for all wave lengths and the compensation stripe will appear completely black without any chromatic compensation, as if the minerals were perfectly normal. On the contrary a hypothetical mineral without any dispersion of birefringence would appear slightly subnormal. It shows a yellowish red bordered compensation stripe before the average compensation is reached, and a bluish one on the side of over-compensation (see fig. 21).

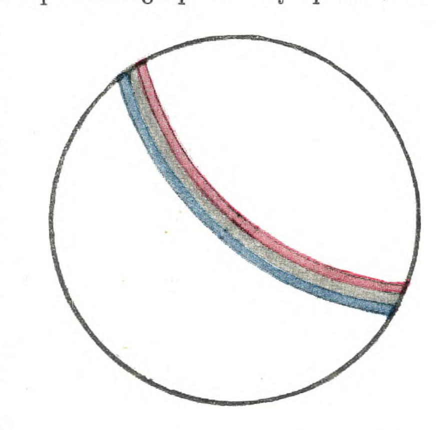
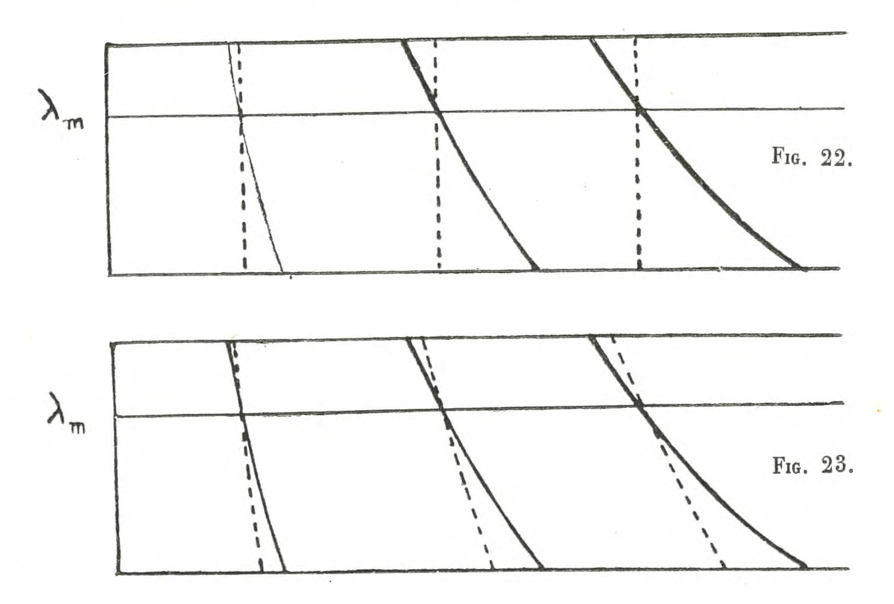


FIG. 21. — The compensation band in the diagonal position showing coloured borders, which indicate that the birefringence for red is greater than for violet.

Therefore, by using quartz or calcite compensators, it is the relative dispersion of birefringence, and not the absolute one, that falls under observation.

Evidently, this fact does not lessen the diagnostical value of the method of chromatic compensation, but it must be taken into consideration in acurate research work (see fig. 22, 23).



The compensation at different retardations.

absisca = the retardation.

ordinate = the wave lengths of the visible spectrum.

λm = A medium wave length in the visible part of the spectrum for which the compensation is supposed to occur.

⋱ = The dotted lines are the retardations of the compensator in various positions.

╲ = The full lines are the curves of the retardations representing a strongly dispersive mineral for various thicknesses.

Fig. 22.— Shows the compensation with a usual compensator made of a non-dispersive material.

Fig. 23.— Shows the compensation with a usual compensator the material of which shows itself a slight dispersion of birefringence.

Practical Application of the Chromatic Compensation

This chapter is intended to ascertain the limits of the applicability of the chromatic compensation method. This was achieved by measuring the amount of colouration in a compensation band in relation to the dispersion of the mineral. The dispersion for the same mineral (keeping the same orientation) was also measured in the usual way using a monochromator or filters. The results were compared.

For this purpose a Berek compensator was used. The constant of the Berek was calculated for D-light, and also for red and blue light of known wave lengths.

As a strong monochromator was not available, red and blue filters of average wave lengths of $440 \mu\mu$ and $642 \mu\mu$ were used. The constant of the Berek was corrected according to the dispersion of birefringence of calcite to fit these filters.

For calcite $R_C : R_D : R_F$ is $0.987 : 1 : 1.03$.

But since the filters used do not correspond with C and F light so for these filters $R_{\lambda=642} : R_D : R_{\lambda=440}$ is $0.988 : 1 : 1.045$ (R is the retardation).

From the general formula of the Berek we have $C.f(i)$ substituting with the above deduced results we get :

$R_{\lambda=642}$	$= C\ (0.988)\ f(i)$	for red.
R_D	$= C\ (1)\ f(i)$	for yellow.
$R_{\lambda=440}$	$= C\ (1.045)\ f(i)$	for blue.

In this manner the constant of the Berek for the corresponding filters are calculated.

Measurements for a titanaugite section :

(from Limburgite of Kaiserstuhl, Rosenbusch collection No. 346)

The above section of titanaugite, cut perpendicular to the acute bisectrix with positive optic sign and a birefringence for red greater than for violet, was treated as follows :

1. By direct compensation in white light (applying the chromatic compensation method). The positions of the coloured and black borders

of the compensation band were brought alternatively to the centre of the field so the corresponding retardations are obtained and tabulated (the reason why the retardations were used to express the width of the bands is discussed later).

For each orientation 8 positions were measured, namely four positions on each side of the Berek. In each position at least five measurements were taken. Finally, we get the retardations R', R'', R''', R'''' where the difference $R' - R''''$ is the width of the compensation band including the coloured borders, let it be called L. $R'' - R'''$ is the width of its greyish part only, and let it be L_o. The difference $L - L_o$ expresses the sum of the widths of the two coloured margins.

2. Another series of measurements was carried out using the red and blue filters, besides the sodium light for yellow, as is usually done to get the dispersion.

These measurements were compared with those of the chromatic compensation. The experimental treatment and the results for the above measurements are given below :

1. Measurements for the titanaugite section in the direction of the acute bisectrix $= n_g$, applying the chromatic compensation method.

For this purpose the substage diaphram was partly closed and a high power objective, of aperture 0.85, was used.

The results are as follows :

$R' = 201.4\mu\mu$ $\qquad R'' = 142.9\mu\mu$
$R''' = 104.2\mu\mu$ $\qquad R'''' = 66.4\mu\mu$
$L_o = 38.7\mu\mu$ and $\qquad L = 135.0\mu\mu$

These measurements have an average margin of error in R' and R'''' of $\pm$ 2.3 and in R'' and R''' of $\pm$ 0.8.

These errors are present for the measurements of one set at the same time. But if the set of measurements is repeated at another time or another day, the difference would be great due to physiological factors (as will be discussed later); so that the previous errors mentioned are negligible with respect to these differences.

The following results are the positions for red (r), blue (b), and sodium light (D).

$R_r = 116.7\mu\mu \qquad R_D = 110.7\mu\mu, \qquad R_b = 108.1\mu\mu$

The Ehringhaus number $N = \frac{R_D}{R_C - R_F}$ where R_C and R_F are the retardations in the C and F light of the spectrum.

But as, in our case, the measurements are carried out by red and blue filters which do not have the same wave lengths as C and F, we shall get another value, call it N', which is related to N.

In the above case the retardation (or birefringence) in red is greater than in blue and we get $N' = \frac{R_D}{R_r - R} = + 12.87.$

From these latter results and the former ones obtained by chromatic compensation, it is clear that the mineral has dispersion with $B_r > B_v$.

2. Measurement of the previous section of titanaugite but with different orientation : The direction of observation lies in the optic axial plane, making with n_g an angle of 12° towards [001]. The results of chromatic compensation and filters are the following :

Chromatic compensation :

$R' = 207.5\mu\mu \qquad R'' = 79.8\mu\mu$
$R''' = 65.9\mu\mu \qquad R'''' = 14.9\mu\mu$
$L_o = 13.9\mu\mu \qquad L = 192.6\mu\mu$

Using filters and sodium light :

$R_r = 83.4\mu\mu \qquad R_D = 74.5\mu\mu$
$R_b = 68.2\mu\mu$
therefore, $N' = + 4.9$

3. The same titanaugite section and the direction of observation lies again in the optic axial plane, but makes with n_g an angle of 12° towards [001].

Chromatic compensation :

$R' = 220.3\mu\mu \qquad R'' = 143.2\mu\mu$
$R''' = 96.2\mu\mu \qquad R'''' = 43.2\mu\mu$
therefore, $L_o = 47.0\mu\mu$ and $L = 177.1\mu\mu$

Using filters and sodium light :

$R_r = 117.8\mu\mu$ $\qquad R_D = 115.3\mu\mu$
$R_b = 110.7\mu\mu$
therefore, $N' = +16.2$

4. In this case the direction of observation lies in the plane $n_g - n_m$ and makes an angle of 20° with n_g.

The measurement of the chromatic compensation stripe gave the following :

$R' = 241.5\mu\mu$ $\qquad R'' = 135.5\mu\mu$
$R''' = 97.7\mu\mu$ $\qquad R'''' = 53.0\mu\mu$
therefore, $L_o = 37.8\mu\mu$ and $L = 188.5\mu\mu$

Using red and blue filters, and sodium light :

$R_r = 122.2\mu\mu$ $\qquad R_D = 115.3\mu\mu$
$R_b = 110.7\mu\mu$
therefore, $N' = +10.0$.

5. The direction of observation makes an angle of 20° with n_g and lies near [001] in a plane containing n_g and forming an angle of 40° with the optic axial plane.

Direct chromatic compensation :

$R' = 242.1\mu\mu$ $\qquad R'' = 135.2\mu\mu$
$R''' = 100.0\mu\mu$ $\qquad R'''' = 36.6\mu\mu$
therefore, $L_o = 35.2\mu\mu$ and $L = 205.5\mu\mu$

Using red and blue filters, and sodium light :

$R_r = 117.2\mu\mu$ $\qquad R_D = 109.2\mu\mu$
$R_b = 104.7\mu\mu$
therefore, $N' = +8.7$

For comparison the values obtained from the above results of measurements have been collected in the following table :

TABLE 12.

	Number of orientation	L_o	L	$\frac{L}{L_o}$	$R_r - R_b$
Decreasing Dispersion ↓	(2)	13.9	192.6	13.8	15.2
	(5)	35.2	205.5	5.8	12.5
	(4)	37.8	188.5	4.9	11.5
	(1)	38.7	135.0	3.4	8.6
	(3)	47.0	177.1	3.7	7.1
	Number of orientation	$\frac{1}{N'}$	$N' \frac{L}{L_o}$	S'	T'
Decreasing Dispersion ↓	(2)	+ 0.204	67.6	0.12	0.084
	(5)	+ 0.114	50.5	0.074	0.040
	(4)	+ 0.10	49.0	0.060	0.040
	(1)	+ 0.077	43.8	0.054	0.023
	(3)	+ 0.062	59.9	0.022	0.040

L = The width of the coloured compensation band, expressed as a difference of retardations.
L_o = The width of the greyish black part of the compensation band, expressed as above.
$R_r - R_b$ = The difference of retardations for red and blue filters.

The table is arranged according to the decreasing dispersion of birefringence. It is noticed that the value $\frac{L}{L_o}$ is decreasing with the decrease of the dispersion, *i.e.* related to the dispersion of birefringence in a somewhat similar manner as $\frac{1}{N'}$, and as results from the quotient $N' \frac{L}{L_o}$

It is evident that these values vary almost proportionally. This relation is, however, far from being constant, because the thickness of the mineral plate (section, cleavage flake etc.) and the physiological factors interfere strongly, as will be shown later (p. 84).

The Chromatic Compensation on Minerals of Strong Dispersion

The chromatic compensation method was applied to a mineral of strong dispersion. A cleavage flake of Heulandite, with the cleavage plane perpendicular to the acute bisectrix, and having an average optic axial angle of 55° was treated.

It has been established from the theoritical discussion that the visibility of the effect of dispersion of birefringence increases with the increase of retardation for the same orientation. For this purpose the chromatic compensation was applied to cleavage flakes of different thicknesses, using the same conditions of illumination and an objective of the same aperture as above.

The final results are tabulated as follows :

Table 12 *a*.

Retardation in white light $\mu\mu$	R' $\mu\mu$	R'' $\mu\mu$	R''' $\mu\mu$	R'''' $\mu\mu$	L_0 $\mu\mu$	L $\mu\mu$
(1) 362.8	428.5	383.7	342.0	290.4	41.7	196.4
(2) 757.0	839.5	770.9	743.0	683.9	27.9	155.4
(3) 1503.0	1607.0	1510.0	1496.0	1343.0	14.0	264.0

Retardation in white light $\mu\mu$	$\frac{L}{L_0}$	$\frac{1}{N'}$	S'	T'
(1) 362.8	3.3	— 0.088	— 0.017	— 0.071
(2) 757.0	5.6	— 0.088	— 0.017	— 0.071
(3) 1503.0	18.9	— 0.088	— 0.017	— 0.071

In the above table the value L_0 is about inversely proportional to the retardations. For a great thickness, and hence for high retardations, this value L_0 becomes zero, and so the whole compensation band appears coloured. The complementary colours replace the black compensation band. This case of high dispersion of birefringence shown by chromatic compensation in the above example, is similar to the case of complete colouration of isogyre in conoscopic figures of strong optic axis dispersion.

Finally, it is of interest to note that the approximate proportion of $\frac{1}{N'}$ and $\frac{L}{L_0}$ which can be seen in table (12 *a*), does not exist in the above table (12), which shows, to the contrary, that $\frac{L}{L_0}$ varies strongly with the change of thickness, *i.e.* with the variation of retardation.

Factors Determining the above Results

To discuss the factors determining the chromatic bands of compensation, let us first begin with the case of no dispersion of birefringence. In this case we have a black compensation stripe, the width of which, expressed as a difference of retardation, is constant, and let it be $2R_x$. The apparent width is constant for quartz wedge, but is a function of (i) for the Berek. This is the reason why the retardation is used to express the above measurements, instead of taking the $f(i)$ or measuring the width directly by an eye-piece micrometer. These facts are true also for the compensation stripes in monochromatic light, whatever may be the dispersion of birefringence.

In all the measurements carried out the power of illumination was kept constant, using a lamp of a certain power and keeping it always at the same distance from the mirror of the microscope. It was found that the luminosity affected the width of the compensation band. We can say that the value $2R_x$ for example (the limiting value of the borders of the compensation band) is a function of the intensity of light.

Mathematically, we have :

$I = I_0 \sin^2 2\rho . \sin^2 (\pi . \frac{R'}{\lambda})$ (see Niggli 1924, Part I p. 406).

Where I = the resulting intensity.

I_o = the initial intensity of the source of light.

ρ = the angle between the vibration directions of the Nicols and that in the mineral plate.

λ = the wave length.

When the mineral is in the diagonal position $2\rho = 90°$ and $I = I_o \sin^2 (180. \frac{R_x}{\lambda})$.

where R' is the retardation in a given direction.

For limiting value R_x we have $I_x = I_o \sin^2 (180. \frac{R_x}{\lambda})$.

If the value I is smaller than I_x we see a black compensation band, because the intensity of the light is beyond our sensibility. Briefly, the value R_x depends upon the intensity of light. But R_x also depends on the wave length for the following reasons :

(*a*) Physically : according to the above equation R_x is a function of the wave length λ.

(*b*) Physiologically : the sensibility of the eye varies with different wave lengths.

If no dispersion is present, the black stripe in white is an integral of R_x from $\lambda = 700 \mu\mu$ to $\lambda = 400 \mu\mu$.

If the dispersion of birefringence occurs, the matter becomes still more complicated, as the eye sensibility for colours is variable.

According to the international commission of illumination, the relation between the wave length and the sensibility of the human eye is given in the following table :

TABLE 13.

Wave length in $\mu\mu$	Sensibility
400	0.04
450	3.8
500	32.3
550	99.5
600	63.1
650	10.9
700	0.41

(abbreviation of the table in Handbuch der Physik, 1928 vol. 19, p. 11).

The sensibility is given in values relative to a maximum of 100. From this table the maximum sensibility is at the wave length of about $550 \mu\mu$.

The following table gives some special wave lengths with the corresponding relative visibility (obtained from curve 8 *b* p. 12 in the above mentioned book).

TABLE 14.

Special wave lengths in $\mu\mu$	Relative visibility
656 = C	9.0
642 = red filter	16.0
589 = D	76.0
486 = F	18.0
440 = blue filter	2.5

If no dispersion of birefringence exists in the mineral or the compensator (or if the dispersion is equal in both) all R are compensated at once. For a definite wave length the limiting intensity is then $I_{x\lambda} = \frac{1}{k_\lambda} . I_{x_D}$

If we combine this equation with the one mentioned above we get a complicated relation, which would show the variation of R_x with all the different factors mentioned.

For practical purposes regarding the applicability of the method of chromatic compensation, it would be useless to further develop this mathematical treatment. It is sufficient to have demonstrated that the visibility of the chromatic compensation depends on all the above mentioned factors, and can therefore hardly be used for quantitative determinations. But the simplicity of the method makes it useful for qualitative and semi-quantitative diagnostical work.

SUMMARY AND CONCLUSIONS

In the present work the phenomena of the dispersion of birefringence are exposed in a general manner, dealing with the different problems that explain or illustrate them.

Stress is laid upon the establishment of the limits of the direct visibility of the anomalies of interference colours and their quantitative or semi-quantitative determination by the methods of compensation in monochromatic light or of chromatic compensation in white light. The number of Ehringhaus and the symbol of Penta, which are supposed to give a numerical expression for the dispersion of birefringence, are discussed and found to be inadequate in certain cases. A new symbol of the dispersion of birefringence is introduced. It gives a more acurate quantitative description of the dispersion curves, even in the case of the occurrence of extreme values within the visible part of the spectrum.

The relations of the dispersion of optic axes and bisectrices with the dispersion of birefringence are treated and the resulting phenomena, to be observed in the conoscope, are discussed. The results are represented graphically in a nomogram which shows the quantitative relation between the apparent width of the isogyre and the maximum birefringence, the optic axial angle and the thickness of the crystal. These extremely interesting relations have, till now, never been treated quantitatively.

A critical discussion of Rittmann's method of chromatic compensation shows that this method is, for its easy application, of great use for semi-quantitative measurements.

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UN TOUR AU KOUWEIT [1]

PAR

BISHR FARÈS

Commandée depuis des siècles par la pêche des perles, la vie au Kouweit prend brusquement un tour nouveau en raison de la récente installation de l'industrie pétrolière. Les mœurs se transforment, les sentiments aussi autant que leur expression : ainsi, les chants inspirés par la mer et le désert vont bientôt disparaître.

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[1] Communication présentée en séance du 2 février 1959, avec audition d'enregistrements sur ruban, et projection de documents photographiques. Malheureusement, le regretté D[r] Farès n'en a rien remis à l'Institut. Nous nous contentons donc de signaler cette communication.

UN FAUX DINAR AYOUBITE FRAPPÉ PAR LES CROISÉS AU NOM DE SALADIN [1]

PAR

PAUL BALOG

Les dinars d'imitation fatimite ainsi que les dirhems d'imitation ayoubite frappés par les Croisés sont connus des numismates.

Il semblait pourtant que les Croisés n'émettaient point des dinars contrefaits d'après les émissions des Ayoubites et se contentaient de contrefaire des pièces d'argent au faciès de cette dynastie. Une pièce d'or observée par l'auteur révise ces données : il s'agit d'un dinar au nom de Saladin, présentant des gravures qui imitent maladroitement l'écriture arabe.

[1] Communication présentée en séance du 2 février 1959. Le Prof. Balog ne nous en ayant pas donné le texte, nous devons nous contenter d'en publier ce résumé.

RELATION BETWEEN SOLAR RADIO EMISSION
AND
THE EARTH'S MAGNETIC FIELD [(1)]

BY

R. N. SEDRA AND L. SEFIEN

ABSTRACT

Solar radio emission on a wave-length of about 3.7 metres was recorded together with variation in the horizontal component of the Earth's magnetic field during the period from December 1957 to March 1958.

The time difference between magnetic and solar disturbances was found to have a mean value of 4 minutes, which could be explained as the time necessary for the ionisation of the upper atmosphere by the ultra-violet radiation.

INTRODUCTION

Early observations of Appleton (2) and Hey (3) indicated that abnormal radio noise was generated by the sun when sunspot groups appeared on its surface.

Ryle and Vonberg (4) tried to ascertain whether the origin of the noise was in the spot itself or whether a much larger fraction of the solar surface was in a condition to emit enhanced noise. They devised a radio interferometer using two separate aerials, each receiving the solar noise on a wave-length of 1-7 metres spaced at a distance which could be increased to 350 metres. These aerials were connected to the

[(1)] Communication présentée en séance du 2 février 1959.

common input of the radio receiver and the variations in signal strength at the output corresponded to the fringes in optical interferometers.

If a source of radio emission moves through such an aerial beam, the effect observed in the output of the receiver will depend on the angle subtended by the source.

By measuring the ratio of the maximum to minimum signal at different aerial spacings, the effective source diameter can be determined which amounts to the same diameter as that of sunspots.

If was therefore concluded that radio waves are emitted from a region which is of the same order in size as that of the visual sunspot.

The spectrum of the solar noise emission was studied by Hey (5) and others. The intensity over a range of wave-lengths from 1.5 to 12 metres was measured and the maximum intensity appears to be in the region of 3 metres.

During solar activity, chromospheric eruptions or solar flares occur in the neighbourhood of sunspot groups; intense ultra-violet radiation is emitted which reaches the ionosphere and causes a disturbance in the Earth's magnetic field.

The aim of this paper is to record simultaneously variations in the horizontal component of the Earth's magnetic field and solar radio emission, on the same chart, and to ascertain whether there is a relation between the two phenomena. The results are taken as a contribution to the Geophysical Year programme.

MAGNETIC RECORDER

The apparatus used for measuring the variations in the horizontal component of the Earth's field is a saturated core magnetometer, fully described elsewhere (6).

The principle of the magnetometer depends on the saturation characteristics of the hysteresis loop for material of high permeability (mumetal) placed in the Earth's field. Due to the Earth's field, the hysteresis loop will be unsymmetrical with the result that the output current will contain even harmonics. This even harmonic content depends on the Earth's magnetic field.

A constant A. C. current of frequency 1000 cycles/sec. is passed in primary coils whose cores are made of mumetal. The output from the secondary coils contains even harmonics of the fundamental frequency of which the second harmonic is filtered by a band pass filter.

The filtered second harmonic is amplified, rectified and the resulting direct current, again amplified. The output of the D. C. amplifier is compensated and then connected to a recording milli-ammeter.

As the effect of the main field is compensated, so any variation occurring in the Earth's field may be recorded.

The apparatus is sensitive to variations in the Earth's magnetic field of the order of 1γ ($1\gamma = 10^{-5}$ gauss).

SOLAR NOISE RECORDER

The solar noise receiver (7) is a radar receiver of band-width about one mega cycle/sec. It is supplied with a double folded dipole aerial which may be rotated in vertical and horizontal directions and of natural frequency 81 m. c./sec.

The output of the receiver is rectified, compensated and then connected to the recording milli-ammeter. Directing the aerial to the sun during the day, variations in solar radio emission may be recorded and is calibrated by a diode noise circuit. The noise factor of the receiver is 11.71.

RESULTS

Solar radio emission and variations in the horizontal component of the Earth's magnetic field were recorded simultaneously on the same chart, during the period from December 1957 to March 1958.

The records have been analysed and the results given in tables (1), (2), (3), (4), (5) and (6).

The intensity of solar radio emission is expressed in watts per meter^2/m. c./sec. and the time of occurrence in Greenwich mean time.

Variations in the horizontal component of the Earth's magnetic field are expressed in γ from a constant value 30800 γ for the main field.

TABLE 1. — December 1957.

Date	Solar Disturbance: Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	Maximum Intensity in w/m² (c/sec)⁻¹	Magnetic Disturbance: Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	30800 γ + max. Intensity in γ	Time diff. Solar-magnetic (m)
3	10	48	5	4	20×10^{-17}	10	54	5	30	103	— 6
5	—	—	—	—	—	7	2	2	2	104	—
7	—	—	—	—	—	7	7	1	6	101	—
10	8	3	—	3	-17×10^{-17}	8	8	—	20	104	— 5
16	9	2	—	23	-18×10^{-17}	9	6	—	25	105	— 4
18	8	48	1	10	3×10^{-17}	8	53	1	7	110	— 5
28	16	30	—	2	4×10^{-17}	16	35	—	20	101	— 5
29	—	—	—	—	—	8	40	3	20	136	—
31	—	—	—	—	—	13	12	4	10	— 74	—

TABLE 2. — January 1958.

Date	Solar Disturbance: Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	Maximum Intensity in w/m² (c/sec)⁻¹	Magnetic Disturbance: Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	30800 γ + max. Intensity in γ	Time diff. Solar-magnetic (m)
4	—	—	—	—	—	8	20	2	20	104	—
5	—	—	—	—	—	7	14	1	50	127	—
6	—	—	—	—	—	6	20	2	14	130	—
7	—	—	—	—	—	6	12	1	40	127	—
8	—	—	—	—	—	5	20	3	30	135	—
9	—	—	—	—	—	6	15	1	30	127	—
27	16	39	—	5	-22×10^{-17}	—	—	—	—	—	—
28	—	—	—	—	—	11	20	2	10	115	—
29	7	36	—	2	-2×10^{-17}	7	40	—	30	107	— 4
30	8	23	—	1	-11.5×10^{-17}	8	25	1	10	120	— 2
31	—	—	—	—	—	8	8	14	30	124	—

TABLE 3. — February 1958 — Solar Disturbance.

Date	Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	Maximum Intensity in w/m² (c/sec)⁻¹
3	11	6	—	31	-10×10^{-17}
4	11	47	—	< 1	-18×10^{-17}
»	9	32	—	4	18×10^{-17}
5	9	16		31	6×10^{-17}
6	10	2	—	58	12×10^{-17}
9	11	45	—	7	12×10^{-17}
11	10	20	—	2½	-29×10^{-17}
26	10	45	—	< 1	-27×10^{-17}
»	8	52	—	1½	-16×10^{-17}
»	11	35	—	5	-16×10^{-17}
27	—	—	—	—	—
»	8	25	—	< 1	-22×10^{-17}
»	9	42	—	5	-16×10^{-17}
»	10	15	2	50	-27×10^{-17}

TABLE 4. — February 1958 — Magnetic Disturbance.

Time of beginning G. M. T. (h)	(m)	Duration (h)	(m)	30800 γ + max. Intensity in γ	Time diff. Solar magnetic (m)
11	12	1	20	122	— 6
11	51	—	50	139	— 4
9	35	—	20	129	— 3
9	22	—	55	114	— 6
10	6	—	20	102	— 4
11	49	1	5	103	— 4
10	25	7	10	— 251	— 5
10	48	—	20	100	— 3
8	57	—	45	121	— 5
11	40	—	15	130	— 5
6	4	1	10	105	—
9	30	—	20	129	— 5
9	46	—	30	134	— 4
10	18	1	20	138	— 3

TABLE 5. — March 1958 — Solar Disturbance.

Date	Time of beginning G. M. T.		Duration		Maximum Intensity in w/m² (c/sec)⁻¹
	h	m	h	m	
1	9	50	1	26	— 16×10^{-17}
—	13	52	—	2	— 13×10^{-17}
2	7	6	—	54	38×10^{-17}
—	9	15	1	15	38×10^{-17}
—	13	5	—	55	38×10^{-17}
3	8	7	4	57	— 20×10^{-17}
—	14	44	—	42	— 22×10^{-17}
6	8	15	—	1	— 8×10^{-17}
8	8	50	2	50	8×10^{-17}
9	8	40	1	35	— 13×10^{-17}
—	12	40	—	20	— 12×10^{-17}
11	7	44	—	3	— 38×10^{-17}
—	12	30	—	10	— 20×10^{-17}
16	12	—	2	20	2×10^{-17}
18	9	20	2	54	2×10^{-17}
19	9	15	7	3	16×10^{-17}
20	6	40	6	20	38×10^{-17}
23	8	56	—	2	— 38×10^{-17}
25	8	—	3	20	— 38×10^{-17}
28	5	5	7	45	27×10^{-17}
29	6	55	6	5	22×10^{-17}
30	—	—	—	—	—

TABLE 6. — March 1958 — Magnetic Disturbance.

Date	Time of beginning G. M. T.		Duration		30800 γ + max. intensity in γ	Time diff. solar magnetic
	h	m	h	m		m
1	9	55	2	5	139	— 5
—	13	56	—	4	139	— 4
2	7	10	1	10	106	— 4
—	9	20	1	30	141	— 5
—	13	10	1	10	112	— 5
3	8	10	4	45	191	— 3
—	14	51	—	49	117	— 7
6	8	20	—	40	111	— 5
8	8	54	3	6	105	— 4
9	8	45	2	6	109	— 5
—	12	45	—	35	109	— 5
11	7	50	2	10	127	— 6
—	12	35	—	25	127	— 5
16	12	6	1	50	120	— 6
18	9	25	3	25	100	— 5
19	9	19	1	75	105	— 4
19	11	19	5	6	— 2	—
20	6	45	7	5	112	— 5
23	8	59	—	41	155	— 3
25	8	6	2	54	130	— 6
25	10	—	1	5	137	—
28	5	10	7	50	118	— 5
29	7	—	5	6	138	— 5
30	8	20	1	10	150	—
30	9	6	1	4	155	—

CONCLUSION

From the results given in the tables, we observe that the solar radio emissions usually occur before magnetic disturbances. The time difference between the beginning of occurrence of the two phenomena has a mean value of 4 minutes.

This difference may be explained as the time necessary for ionisation of the upper atmosphere by ultra-violet radiation; and the appearance of the magnetic disturbance which is an accumulative effect.

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LA KHANKA ET LE MAUSOLÉE DE FARAG IBN BARKOUK AU DÉSERT DE KAIT-BAY [1]

PAR

HASSAN ABDEL WAHAB

Le conférencier rectifie l'appellation erronée : « Tombeaux des Khalifes » donnée au site du désert oriental à Abbassieh, qui devrait plus exactement s'appeler « Tombeaux des Mamelouks ». En énumérant les principaux monuments qui peuplent cette région, il souligne la beauté des coupoles qui surplombent les mausolées et va jusqu'à baptiser ce site « Cité des coupoles ». Il s'attache surtout à la Khanka (couvent) de Farag Ibn Barkouk dont il donne une description détaillée en relevant les principaux détails architecturaux qui font de ce monument un de plus beaux de l'Islam. Il attire l'attention sur la niche de prière en pierre calcaire d'une grande rareté, sur les dallages en marbre de l'époque fatimide découverts au cours des travaux de restauration et sur le croissant en cuivre décoré d'une barque (semblable à celle de l'Imam El-Chafféi) qui surmonte la coupole du mausolée. Le détail le plus important que révèle M. Hassan Abdel Wahab est l'inscription, découverte sur le tambour de la coupole, fournissant un détail historique. Il s'agit d'une ligne d'écriture en coufique et naskhi à la fois, ce qui ne manquera pas de passionner les archéologues si l'on sait que sous les Mamelouks le coufique était réservé aux versets du Coran.

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[1] Communication présentée en séance du 9 mars 1959. L'auteur ne nous en ayant pas remis le texte, nous en donnons un résumé.

RADIOACTIVITY OF LATE PRECAMBRIAN DYKES AND OTHER MINOR INTRUSIONS FROM ASWAN AND QOSEIR DISTRICTS, EGYPT [(1)]

BY

AMIN R. GINDY

ABSTRACT

The radioactivity of some seventy samples from the latest Pre-Cambrian dykes and other minor intrusions from the districts of Aswan and Qoseir is determined by using nuclear photographic emulsions.

The average radioactivity of the different intrusions expressed in equivalent uranium content in parts per million (eU ppm.) is as follows : for the Aswan intrusions : bostonite-solvsbergite acid intrusions 6.27 (maximum 15.40), fluidized granophyre-felsite intrusions 3.11, dolerite-diorite lamprophyres 3.04, kersantitic intrusions 2.63, camptonitic intrusions 4.03 ; and for the Qoseir intrusions : bostonite-solvsbergite suite 14.66 (maximum 24.45), altered trachytes 3.07 and altered dolerites 2.53.

In both districts, acid intrusions are thus more radioactive than basic ones and, among the basic intrusions of Aswan, the alkaline varieties are more radioactive than their less alkaline equivalents. The Qoseir intrusions are always more radioactive than their corresponding equivalents in Aswan ; a finding which also applies to the pre-existing host-rocks of both areas, thus suggesting alliance to two petrographic provinces of different radioactivities.

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(1) Communication présentée en séance du 21 mai 1959.

I. — INTRODUCTION

The late Pre-Cambrian dykes and related minor intrusions of the Aswan and Qoseir districts display a rich variety and spread of petrographic characters which are on the whole characteristic of the Pre-Cambrian areas of Egypt (see Hume, 1935, p. 499-580). Schürmann (1953, p. 126-127) for example, listed 39 different kinds of dykes from the Pre-Cambrian areas of the Gulf of Suez. He had, however, included, among these minor intrusions, the aplites, pegmatites etc. connected with the major granitic intrusions of these areas.

In the Aswan and Qoseir districts, the minor intrusions are generally considered Pre-Cambrian because they are not seen to cut the overlying Nubian Sandstone but there is no doubt that some post-Cambrian to Tertiary intrusions may go astray and unnoticed among the Pre-Cambrian intrusions. Admittedly, such cases are rare. In the neighbourhood of both Aswan and Qoseir, records of younger intrusions are known : e.g. east of Aswan (Andrew, 1937, p. 21); the 'olivine-dolerite' of Gebel Burka, 20 miles WNW of Wadi Halfa (Lyons, 1894, p. 533-534) and olivine-dolerite intrusions 30 kilometres south of Qoseir town (Sabet, 1958). In the Aswan district, there may be some slight doubt that dyke No. 20 (Map 1) of fresh dolerite might be post-Cretaceous but it is definite that all other intrusions studied here are of Pre-Cambrian age.

The general trend of the late minor dyke intrusions is largely determined by the pre-existing joints, faults and other weak planes in the host rocks. In Aswan, the majority of these late intrusions form two main dyke swarms roughly trending at right angles to each other (Gindy, 1956, p. 105, 131; also fig. 1 of the present paper), while in Qoseir, the most dominant trend is a roughly north-south one, following that of the master-joints and indicating tensional forces and tendencies to open the joints in that direction at the time of these minor igneous volcanic activities (Gindy, 1958, p. 568 and geological map, Plate I). In Aswan, volcanic necks and plugs probably arose at the intersection of master-joint planes or grew on dyke fissures.

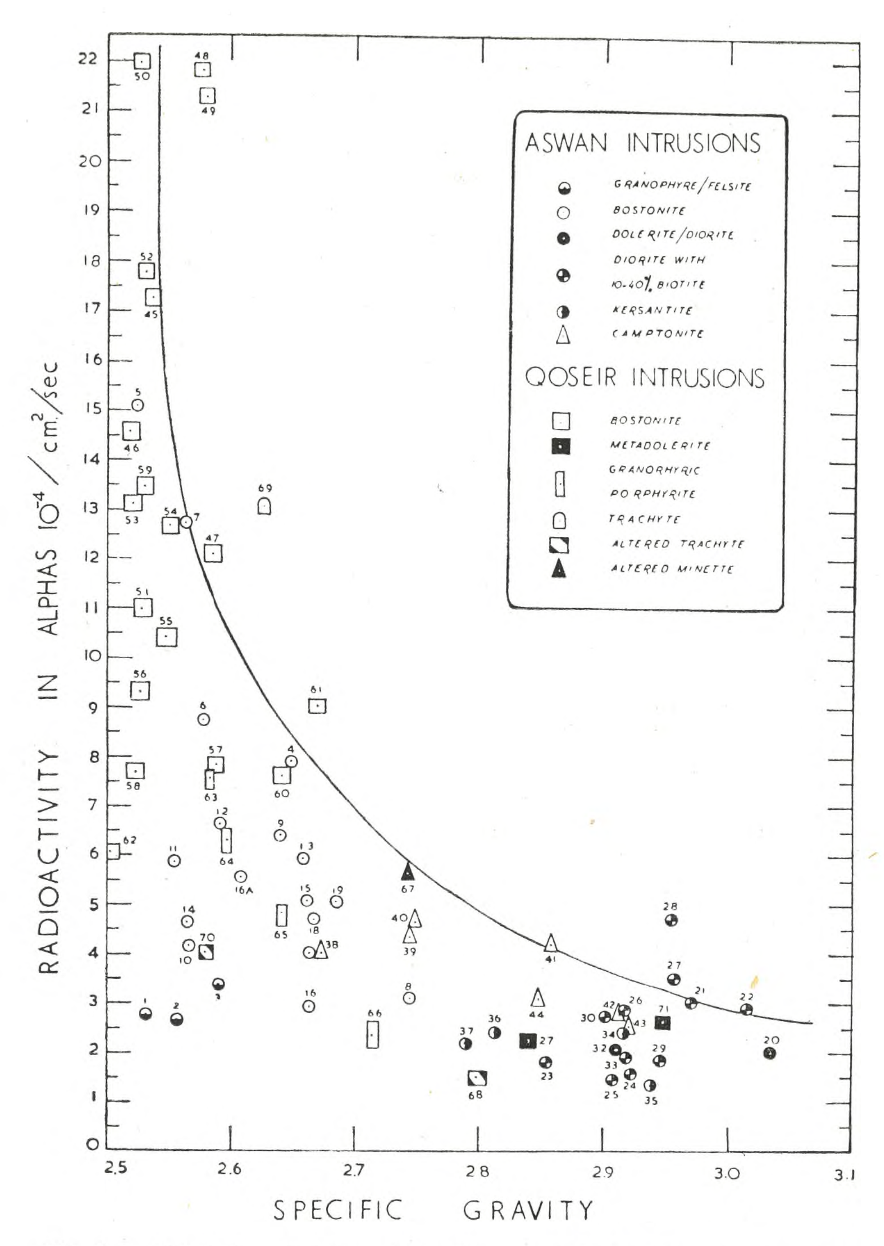


Fig. 1. — Distribution of alpha activity of the sampled minor intrusions of Aswan and Qoseir plotted against their specific gravities.

Petrogenesis : In the writer's opinion, and in the absence of decisive proof, these late dykes and minor intrusions should not be directly related to the late pegmatitic and aplitic intrusions that are clearly connected with the granitic upheavals so common in both regions. This is proved by the fact that in the Qoseir district, these late post-Gattarian minor intrusions traverse all preceding pegmatites, aplites and granites, and even all the quartz veins and « dykes » which can be regarded as the last hydrothermal manifestations of the granitic intrusions. They are not themselves cut by any subsequent intrusions of quartz veins. In Aswan there is evidence that the acid bostonitic dykes cut even the more basic and basaltic members of the late intrusive suite, thus pointing to the absence of any direct evidence of a connection between these late minor acid intrusions and the former granitic activities. They do not form or belong to the aplitic-pegmatitic late stages of the granites of the district. Indeed aplitic dykes connected with the New Granite of Aswan are rare (Gindy, 1956, p. 104) while later bostonite-solvsbergite dykes are most common. These later intrusions must have belonged to a late volcanic episode (or episodes) attending on the isostatic and epeirogenic settling of rock-blocks in those parts of the earth's crust which had earlier undergone geosynclinal and orogenic upheavals, or might have simply belonged to a later tectonic disturbance.

The origin of the late minor intrusions of Aswan were discussed by Rittmann (1953, p. 61), Gindy (1954, p. 496 or 1956, p. 106, and 1959) and Higazy and Wasfy (1957). These minor intrusions were probably formed by more than one mechanism and briefly the late Aswan intrusions could have arisen from any of the following mechanisms :

1. Direct uprise of simatic material along deep fractures, tensional or otherwise, resulting from epeirogenic uplifts and adjustments of sialic blocks closing the geosynclinal history of the terrain. In simple cases of intrusions, without contamination or « hydrous crystallization », dolerites and olivine-dolerites were produced.

2. Crystallization of the above magmas under such conditions that the fugitive constituents were retained during solidification or at least the solidifying rocks were under a constant stream of hyperfusibles (deuteric and metasomatic alterations). Some of the late Aswan intrusions exhibit excellent indications of the change-over from olivine-dolerites and dolerites into diorites, kersantites (pl. IV, B) and camptonites (pl. VI, B to pl. VII, B). Where the magma had retained its alkaline and fugitive residual fractions, it crystallized directly as camptonite showing no trace of earlier changes from olivine-dolerites (pl. VI, A).

3. Differentiation of the simatic magma by crystal fractionation helped by volatiles and fluxes.

4. Various degrees of interaction and assimilation between the simatic magma and the host-rocks. As the latter are to some considerable extent of granitic composition, most of their constituent minerals would, according to the Reaction Principle, melt freely in basalt. This is indicated by the occurrence of arrested intermediate stages of granitic and other country rock xenoliths or xenocrysts in some of the late intrusions. Granophyric outer borders and rims to the xenoliths may form and boundaries between the quartz and feldspar of granite inclusions become curiously sinuous and granophyric.

5. Pure melting and fusion of large « rafts » and « screens » of the host-rocks' inside or at contact with the rising simatic magmas, to form new magmatic pockets of variable composition capable of intrusion (Gindy, 1959).

6. The writer (Gindy, 1959) also suggested that some of the acidic and intermediate late minor intrusions like the bostonites, solvsbergites, granophyres, rhyolitic dykes etc. could have been formed by the fluxing and melting of host-rocks along fractures, joint and other weak planes simply by the surge of hot volcanic vapour, gases and fluxes attending these late volcanic activities or by rising hot exudates and hyperfusible residua during solidification of simatic intrusions. New acid to intermediate igneous dykes and necks are thereby produced (pl. II, B).

7. The infiltration and streaming of the above hot gases and vapour along weak planes of pre-existing rocks could bring about the latter's disaggregation and granulation into intrusive breccias, agglomerates,

granophyres and other gasified or fluidized systems without even generating an important molten phase (pl. II, A).

8. A combination of more than one of the preceding mechanisms in certain conduits is also possible. A rising simatic magma may thus overtake and mix with fluidized systems produced at upper levels solely by the streaming of its volcanic gases and vapour.

Other suggested possible origins for lamprophyres in general, which were not applied to the Aswan or Qoseir intrusions are :

9. Emmons et al. (1953) considered certain lamprophyres to have been formed from the immediate walls of their host rocks by the accumulation of deuteric-type material, principally late alkalic solutions derived from the exsolution of feldspars, modified by selectively resorbed mafic material.

10. Avanasiev [1] suggested that differentiation of the late residual magmatic melts of major intrusions might somehow split them up into an acid fraction from which stem the aplites and pegmatites and a complimentary basic lamprophyric fraction.

In the absence of chemical analysis and due to the complexity and brisk chemical variation of the migmatitic host-rocks of Aswan (granites with variable dioritic and granodioritic relics) it is not possible to tie the relatively potassium-rich minor intrusions (kersantites) or the relatively sodium-rich types (camptonites) to the corresponding diverse potash or soda-rich pre-existing host-rocks but the latters' possible contaminating effect on the ensuing late basic magma must not of course be ruled out.

II. — SAMPLING OF THE MINOR INTRUSIONS FOR RADIOACTIVITY MEASUREMENTS

Sampling of the minor intrusions for radioactivity measurements appeared at first to be an easy matter in view of the fine grain and more or less homogeneous appearance of most of these intrusions. They

[1] Lecture delivered at Cairo University, 5th March, 1959.

do not possess a grain-size-to-volume sampling problem as that presented by the pegmatites and other coarse grained igneous plutonic rocks. On the other hand, in actual practice, obtaining unaltered « fresh » representative samples in the field presented a major difficulty. Many of these dykes have a close prismatic cleavage (jointing) thus affording narrow channels for circulating waters in the otherwise less jointed mainly granitic host rocks. Moreover, there is impelling evidence that strong hydrothermal activities and alterations were at full play not only long after the intrusion and jointing of these intrusive bodies but even during and immediately after their emplacements (the so-called deuteric changes).

The important effect of these alterations on the radioactivity of the rock is vividly displayed by the fact that measurements of the alpha particle radioactivity of the altered and unaltered parts separated from the same hand-specimens (e.g. like those of pl. I, A-B) had shown that the unaltered or least altered parts are more radioactive by a factor ranging from a fraction up to three or four times that of the altered parts. Even apparently similar samples collected from different parts of the same apparently homogeneous minor intrusion showed a difference in radioactivity of a factor of up to two or three. In some cases, the entire intrusion was thoroughly hydrothermally altered and it was impossible to obtain « fresh » samples from it. This applies in particular to the majority of the bostonite-solvsbergite intrusions of both Aswan and Qoseir whose brick red or brown colour is due to the destruction and oxidation of their pyriboles and other ferromagnesian constituents into hematite pseudomorphs and the intense clouding and staining of their feldspars by very fine hematite particles. Such cases are so numerous that it was found unwise to discard such intrusions.

Thus in measuring the radioactivity of the minor intrusions, their state of alteration as judged in field, handspecimens and thin sections must be taken into consideration. For the sampled collection, this is mentioned in the last column of (table 1). With certain exceptions, the comparatively least altered acid minor intrusions of Aswan and Qoseir (the bostonites and solvsbergites) are the most radioactive. On the other hand, among the initially least radioactive intrusions such as the basic doleritic

intrusions, alterations seems to have a reversed effect on their radioactivity, rendering the altered parts more radioactive as compared with the fresh parts. This seemed to be in part due to the adsorptive effects of altered products on radioelements in circulating solutions, or late deuteric residua. The evidence available from camptonitic (and some kersantitic) intrusions indicates that the increased radioactivity of these basic intrusions was effected not by circulating epigene solutions but by alkaline deuteric fugitive constituents attending on and contemporaneous with the same volcanic activities.

On the whole, in Aswan the basic intrusions seem to be less altered hydrothermally compared with their acid companions of the bostonite-solvsbergite suite, probably indicating a more intimate relation between the genesis of the latter and the gaseous and volatile constituents.

Theoritically speaking, alteration by circulating solutions or uprising vapours and volatiles can have a two-way effect on the radioactivity of rocks; for by leaching away radioactive ingredients from some intrusive body or parts therefrom, these solutions or volatiles might increase the radioactivity of other rocks or other parts of the same intrusion where the transported radioelements might eventually be deposited or fixed by some reason or other such as change of temperature, pressure, chemical changes, adsorption etc.

Another factor to be taken into consideration in the selection of samples is the xenolithic or xenocrystic character of certain dykes or parts thereof. Radioactivity measurements on xenolithic and non-xenolithic parts of the same intrusion may show a change in radioactivity (cf. samples 17 and 18, table 1 and pl. III, B).

A single isolated sample for a minor intrusion is thus almost worthless and cannot be taken confidently as representative of the whole intrusive body from which it was collected, whatever care was taken in its selection. From the above consideration and in order to increase the statistical significance of the samples analysed for radioactivity without unduly carrying out a large number of laboratory determinations, recourse to composite sampling was undertaken. From each of the sampled intrusions, several samples weighing from 50 to 150 grams were collected from the least weathered parts of the intrusion. These samples were then crushed and equal fractions of each crushed sample were combined to form one composite sample. In order not to mask any periodic change in radioactivity along the length of the dykes, the fractions aggregated in one composite sample in certain intrusions were all taken from discrete samples collected within a span of not more than 10 metres along the length of the outcropping dyke. When the whole intrusion or part thereof was thoroughly hydrothermally altered, composite samples were also prepared from the altered parts.

In spite of these precautions and in view of the capricious variable hydrothermal alterations and weathering to which some of these minor intrusions have been subjected, some significant sampling error probably still exists.

III. — PETROGRAPHY OF THE SAMPLED INTRUSIONS

The alpha radioactivity of 72 composite samples of the late minor intrusions were determined : 44 samples of the Aswan intrusions and 28 of the Qoseir district. In this paper, the samples are given consecutive numbers and the same numbers are given to the sampled intrusions whose location in the Aswan district is indicated in Map. 1. Thin sections have been prepared from all sampled intrusions in order to correlate the type of rock with its radioactivity and to assess the degree of alteration. The sampled intrusions do not entirely cover all the rock types known to be present in the two districts. This is particularly the case with the Aswan minor intrusions since some of the rare intrusions reported by certain writers such as true «andesites», «rhyolites», «augitites», «monchiquites» and «picrites» [1] were not encountered in the sliced and sampled intrusions.

In Aswan, acid, intermediate and basic late minor intrusions are all fairly and equally represented. The majority of the basic and some of the intermediate minor intrusions of Aswan are dioritic lamprophyres including diorites, quartz-diorites, spessartites and kersantites. An original

[1] Some sampled intrusions, e.g. Nos. 43 and 44 (pl. VI, B and pl. VII, A-B) could have been considered as monchiquites and picrites had their olivine remained fresh and had they been contemporaneous with the amphibole.

doleritic or olivine-doleritic ancestry for all is either clear or implied, and indeed there still occur some, though few, true dolerite or olivine-dolerite dykes.

The acid intrusions are chiefly of bostonite-solvsbergitic petrographic affinities but the chief petrographic difficulty encountered in these acid to intermediate minor intrusions of Aswan (as well as in the corresponding Qoseir intrusions) is the exact determination of the composition of their alkali feldspar laths occurring in typical panidiomorphic, very rarely porphyritic or granular, trachytic texture; sometimes with occasional flow structures parallel to the walls of the dyke. The majority of these dykes show signs of strong hydrothermal alterations with pre-existing pyriboles, probably alkaline amphiboles, oxidized to magnetite or hematite pseudomorphs and the feldspar laths are strongly clouded and stained red. In some of the fresh intrusions, albitic oligoclase and later orthoclase crystals occur together in separate crystals or the potash-rich feldspar may form the outer mantles for the former (e.g. sample 34); however in almost all other fresh intrusions, the alkali feldspar laths show characteristics suggesting compositions falling between orthoclase and albite, with the majority of cases tending to the side of a potash-albite. Many of the «albite» laths show alternating short spindle-shaped albite-twin lamellae that do not pass through the entire crystals, but no typical chequered or chessboard albite has been noticed. Whether such complex alkali feldspars are due to exsolution from previous high temperature homogeneous K-Na-feldspar or to «deuteric or metasomatic» replacements is not clear. In the absence of chemical analyses, no precise composition of such alkali feldspars could be given. Thus in the following petrographic description of sampled intrusions, «albite laths» implies albite that probably contains significant amounts of the orthoclase molecule, while «orthoclase laths» are probably soda-rich potash feldspars. The former tend to occur in the solvsbergites, the second in the bostonites, but both types of intrusions are generally referred to simply as bostonites or bostonitic intrusions unless otherwise stated.

In the *Qoseir district,* on the other hand, the overwhelming majority of the minor intrusions are of the acidic bostonite-solvsbergite suite

which accounts for the smaller number of the studied Qoseir samples. The first 18 Qoseir samples (45 to 62) belong to this typical acid lamprophyric suite, and are representative of the well developed roughly north-south long dyke swarms and others of the district (see Geological Map, Gindy, 1958, Plate I). The remaining ten samples (63 to 72) come from comparatively rare, sometimes even odd single intrusions, most of which are of doubtful origin in the pre-Cambrian history of the region. Some of these may even be pre-Gattarian as they are exposed only in the country rock of the Gattarian, mainly granodioritic-dioritic diapir intrusions of the district, and have not been seen to cut the latter as mentioned in the petrographic description of some individual sampled intrusions given below.

A general petrography of some of the Aswan minor late intrusions have already been given by Ball (1907), also quoted in Hume (1935) who gave the petrography of several minor late intrusions from the Eastern Desert and Sinai, Andrew (1935), El Shazly (1954), Attia (1955) and Higazy and Wasfy (1957). In the following pages are brief synopses of the chief petrographical features of each sampled intrusion in the present paper. These are not intended to be complete but are more concerned with features related to the subject in hand. The volume percentage modal analyses expressed were determined by means of a Dollar's integrating stage and, because of the very fine grain of some of the intrusions and of their occasional strong alteration, some of these analyses may be rather approximate.

The Aswan Intrusions

A. — *Fluidized and granulated intrusions, intrusion breccias, «granophyres» and «felsites».*

Sample 1 : From a xenolithic granophyre of peculiar cream colour, actually an intrusion breccia with large irregular xenoliths, especially of silexite. The intrusion itself seems to be traversed by siliceous veins. The sample comes from the matrix which is fine grained, almost isotropic but is probably of devitrified glass showing aggregate polarization with small granophyric aggregates in spherulite-like arrangement. Rather large (up to 2 mm. long) slender

crystals of acid feldspar with highly irregular and frayed outer margins are common as if they were dessiminated xenocrysts being replaced or dissolved into the matrix. Goethite pseudomorphs of slender ferromagnesian microlites are common throughout the matrix. Tiny needles of apatite are also common.

Sample 2, pl. II, A : From a xenocrystic granophyre (fluidized intrusion). Although the dyke appears homogeneous, it is entirely made up of a felsitic granophyric matrix (with aggregate polarization) full of xenocrysts of embayed quartz and acid feldspars. Most of the large quartz xenocrysts show two sets of fluid pores characteristic of the quartz in the granitic-host and indicating original derivation therefrom. Xenocrysts are of all dimensions up to a maximum diameter of 0.5 mm. which is easily attained by many particles indicating that these fragmented particles were previously size-elutriated by uprising volatiles and gases. Opaque granules are relatively few, except those making a late film around the xenocrysts. Some tiny zircons and sericite flakes occur in the matrix while tiny apatite needles are relatively few. The dyke intrusion was probably formed by fluidization processes : host-rocks were pulverized and granulated and partly melted by upsurging fluxes and volatiles along a weak plane during the igneous volcanic activities.

Sample 3, pl. II, B : From the intrusion breccia of Awad Island. This intrusion has been fully dealt with in a separate paper (Gindy, 1959) [1]. It is made up of the constituents of the coarse Aswan granite (biotite, oligoclase, microclineperthite, quartz) fragmented, destroyed, altered or melted in the preceding order by the fluxing action of surging volcanic hypogene volatiles. Fragments of all sizes up to an average size of 1.5 cm. in diameter occur (the latter are mainly of granite fragments or xenocrysts of the large porphyritic microcline of the granite). The matrix is of devitrified glass, granophyric in patches and with opaque relics (now hematite pseudomorphs) after original ferromagnesian material. Some apatite and sericite occur in the matrix.

B. — *Bostonitic suite (Solvsbergites, bostonites, quartz-solvsbergites and quartz-bostonites).*

Samples 4 and 5, pl. I, A : Very fine grained buff-grey bostonitic dykes, in parts pale cream. Typical panidiomorphic texture with slender feldspar laths (alkali feldspar to acid oligoclase), average length 0.2 mm. Intergranular

[1] Also read before the Geological Society of Egypt, 25th March, 1959.

spaces are occupied by a fine granophyric to felsitic mesostasis representing the last crystallized residuum. Few opaque dust granules and almost no pyriboles are present. Tiny zircon and apatite crystals. The two composite samples 4 and 5 are taken from two dykes that probably belong to the same intrusion. Sample 5 is from the fresh cream coloured parts and is the most radioactive of the Aswan samples (eU = 15.40) while sample 4 is from the hydrothermally altered parts of the intrusion becoming much stained with introduced opaque (now goethite) granules. This alteration reduces the alpha radioactivity of the intrusion to about half its original value in the fresh parts. Pl. I, A shows a photomicrograph of a thin section of a specimen from dyke 4 displaying a still unaltered relatively clear inner core surrounded by an outer altered ferruginous part of the intrusion. Sample 5 looks exactly like the fresh parts in pl. I, A.

Sample 6 : From a « coarse » quartz-bostonite. Typical panidiomorphic texture with acid oligoclase laths (average length 0.6 mm. width 0.15 mm.). Outer parts of laths are stained red by hematitic introductions. Intergranular, triangular or polygonal spaces between the feldspar laths are occupied either by a few quartz grains or by tufts of green to brown barkevikite-like amphibole partly altered to brown biotite with tiny dark halos and to black opaque granules. Green chlorite (pennenite) partly replaces both the amphibole and biotite while prehnite replaces some of the biotite. Several tiny dark idiomorphic zircon crystals as well as less frequent apatite and others too tiny or dark to be identified also occur. Mode : feldspar laths 63, ferromagnesian aggregates 25, quartz 10, and opaques 2. Dyke has few small elongated (2-3 mm. long) vesicles partly filled with chlorite.

Sample 7, pl. II, B : The composite sample is collected from the prominent brick red long bostonitic dyke of Gebel el-Dirisa and cutting three dioritic dykes (Nos. 24, 26 and 28). It is made up of long slender radiating to trachytic albitic laths (average length 1.2 mm.), strongly altered and stained red by fine disseminated hematite dust but this vivid red colouring is only restricted to the internal parts of the laths; the coloured part being sheathed in a fresh unstained colourless outer coat. Curiously enough, the opaques outside the feldspar laths are of fresh magnetite and are not replaced by hematite or goethite; although they seem to have replaced at high temperature a pre-existing alkaline amphibole, this cannot be proved. In spite of the ferruginous alteration of the feldspars, frequent small rather fresh biotite

books (*Z* dark olive brown, *X* pale green) occur with some pennenite replacement. Other intergranular spaces between the laths are occupied either by large quartz moulds or by a granophyric residual matrix with aggregate polarization. Approximate mode : albite 84.3, opaques 8.2, quartz 5, and biotite 2.5. Apatite needles seem to be rare but tiny rounded or kidney-shaped granules of zircon occur inside and outside the feldspar laths, causing some halos in the biotite, and must be responsible, at least in part, for the total radioactivity of the dyke. In spite of the red staining and alteration of the feldspar laths and the destruction of the amphiboles, the composite sample from this intrusion is the second most radioactive of all Aswan samples (eU = 13.05 ppm.). It seems that, during solidification, this dyke was at first hydrothermally altered (staining red the feldspars and destroying the amphiboles) but then it received a new lease on life (regenerated) whereby a renewed «fresh» inflow of ingredients caused the growth of new, clear outer jackets to the altered albite and the formation of fresh biotite.

Sample 8 : From an amygdaloidal «basic bostonite» dyke. Feldspar laths and original prismatic ferromagnesian mineral (amphibole?) are almost in equal amounts per volume. The partly altered feldspar laths are about 1.6 mm. long displaying a typical trachytic texture but becoming much larger and coarser in parts of the rock where amygdules increase in volume or number. Vesicles and amygdules are elongated in one direction (that of flow) and the latter are filled jointly or partially by calcite, chlorite and zeolite which also occur disseminated in the matrix of the rock. The ferromagnesian (amphibole) needles are entirely altered to pale chloritic aggregates and hematitic flakes. Magnetite occurs in well defined octahedra and tiny needles of apatite are common all over. This dyke might well have originally been a camptonite like that of pl. VI, A except that the rock, especially the pyribole, has been altered.

Sample 9 : From an actinolitic-tremolite mica-bearing dyke of dark creamy colour. It is a basic fine-grained bostonite with typical bostonitic texture of slender albite laths 0.7-0.6 mm. long, with occasional larger crystals, but with appreciable amounts of an original ferromagnesian mineral now replaced by small radiating tufts of actinolitic tremolite and a pale coloured biotite (*Z* pale yellow brown, *X* colourless : vermiculite?). Tiny sericite and chlorite flakes replace the biotite while albite laths are also partly sericitized and limonitic iron oxides occupy the interstitial crystal boundaries. Opaques (goethite pseudomorphs after pyrite?) are frequent, apatite less frequent.

Sample 10 : From a bostonitic neck. Coarse but rather stout albite laths, about 1 mm. long, with typical trachytic texture. Subordinate ferromagnesian minerals reach about 15 % of the volume of the rock but are now entirely replaced by chlorite and hematite pseudomorphs. Large opaque grains are now of hematite while the feldspar laths are variably stained red, especially along their cleavages where iron oxide stains are mostly precipitated. Tiny interstitial quartz and few apatite needles are present. Chlorite has tiny dark inclusions with faint dark halos round them. Tiny granular fluorite is suspected in matrix.

Sample 11 : From a bostonitic dyke with typical trachytic texture of rather stout albite laths, 0.8-0.4 mm. long, slightly and variably coloured red especially around their peripheries. Original pyriboles and opaques, entirely replaced by goethite, reach about 30 % of the volume of the rock. Minute chlorite flakes and tiny zircons present but rare apatite; rock with tiny, rare vesicles.

Sample 12 : From a typical bostonitic intrusion with trachytic albite laths 2-1 mm. long, with interstitial triangular or polygonal spaces occupied by a leucocratic quartzo-feldspathic granophyric or felsitic mesostasis or by goethite pseudomorphs after pre-existing pyriboles of which no fresh relics remain. Tiny rare apatite needles.

Sample 13 : From an altered bostonitic neck. The usual albite laths in a granophyric mesostasis with aggregate polarization. Pre-existing pyriboles and opaques are replaced by goethite. However, some fresh albite occurs in the rock as if it had recrystallized later. Tiny rare apatite. Amount of ferruginous stain is large giving the rock a much darker appearance than is usual for bostonites.

Sample 14 : From a coarse bostonitic neck with large albite laths, 2 mm. long, crowded together with a small quantity of original interstitial quartz. Polygonal interstitial spaces occupied by the granophyric-felsitic mesostasis or by original ferromagnesian minerals now entirely replaced by goethite. Tiny apatite needles are casual, some with dark cores.

Samples 15 and 16 : These two composite samples are collected from the same intrusion; from the least and much altered parts respectively. Sample 15 resembles sample 14 but has more interstitial quartz. In sample 16, alteration is stronger and iron stains in the albite laths are more vivid than

in sample 15. Again the reduced alpha activity of the more altered part is demonstrated. Mode about : feldspar 72, iron oxide pseudomorphs after pyribole and opaques 26, and quartz 2.

Sample 16 A : From a separate intrusion, but much resembling sample 16 except for its darker colour.

Samples 17 and 18, pl. III, B : The two composite samples are from the same strongly amygdaloidal «basic bostonitic» dyke with fresh albite laths, 0.6-0.4 mm. long, in typical trachytic arrangement. Pre-existing pyriboles are replaced by pistache green, clear yellowish or brownish uralite, chlorite and serpentine pseudomorphs still preserving the original triangular or polygonal shapes of the mould of the original mineral in the intergranular spaces between the laths. The original opaque mineral is partially replaced by goethite. Apatite is a frequent accessory. Mode : feldspar 65, pseudomorphs after pre-existing pyribole 27, and opaques 8. Sample 17 resembles sample 18 but the former is from a xenolithic part of the dyke with some granitic inclusions and was collected near the outer border of the dyke. In the granitic xenoliths peculiar new sinuous border textures occur between the original quartz and feldspars of the granite (pl. VIII, B). The xenolithic part of the dyke has a reduced radioactivity compared with the non-xenolithic part but the significance of this has not been estimated. The degree of weathering and alteration and the presence of amygdules may introduce complicating factors. Amygdules of both samples are filled with a narrow outer chlorite zone and an inner calcite one.

Sample 19 : From a «basic bostonite» resembling No. 17 and having fresh trachytic albite laths but the pyribole (probably amphibole) is entirely replaced by hematite granules. Occasional zeolite occupies intergranular triangular spaces between the laths. Apatite plentiful, rare quartz xenocrysts. Very tiny granules of zircon (?) occur disseminated in all minerals. Mode : albitic feldspar 68, hematite pseudomorphs after a pyribole 28.5, original magnetite 3, and xenocrystic quartz 0.5.

C. — *The dioritic lamprophyric suite (Spessartites, diorites, quartz-diorites and dolerites).*

Sample 20, pl. IV, A : From a coarse dolerite dyke, made up of large broad labradorite laths up to 4 mm. long, crowded together and with enstatite-like pyroxene variably replaced by a small amount of amphibole and a larger amount of biotite (Z nut brown, X colourless) and pennenite. Biotite also arises from some of the opaque plates. Apatite is an important accessory and occurs in robust thick and long prisms (pl. IV, A). The rock as a whole is quite fresh. Mode : plagioclase 65.5, pyroxene with light amphibolic replacements 28.4, biotite and chlorite 3.6, opaques 6.8, apatite 3.4, and interstitial quartz 1.3. This intrusion is among the most basic dykes in the sampled collection and is most probably of Pre-Cambrian age like other minor intrusions.

Sample 21 : From a «medium» grained diorite (spessartite) made up of large porphyritic crystals of basic andesine set in a matrix of smaller crowded crystals of andesine of ill-defined outline, and augite largely being replaced by amphibole-biotite-chlorite tufts. Some flow texture and flow banding are apparent. Quartz granules, sometimes accompanied by red-brown biotite, occur crowded together in a few small rounded inclusions as if they were xenocrystic. Apatite is the most abundant accessory and occurs in large prisms broken up and segmented as if by some late push or flow movement in a largely crystallized intrusion. Mode : andesine 43, pyroxene and its amphibole-biotite-chlorite replacements 47, opaques 7, apatite 2.1, and quartz 0.8.

Sample 22 : From a diorite (spessartite) with varying textures in the same thin section. The main texture is doleritic (subophitic) with well defined labradorite laths, 0.6 mm. long, sometimes crowded together as if by some pushing movement in the last stages of crystallization. Some labradorite laths are bent or fractured. In certain parts, some flow banding is apparent with subparallel laths while in others the texture is different, with radiating laths. Pyroxene crystals are of hypersthene, pleochroic from pink to green, and are largely replaced by tufts of amphibole, nut-brown or red-brown or sepia (Z) biotite and some pennenite. Apatite is of mild frequency, some of its crystals have black cores. Mode : plagioclase 43, pyroxene and its amphibolic replacements 38.6, biotite 11.5, original opaques 6.9.

Sample 23 : From a diorite clearly arising from replacement of a dolerite. This intrusion must have originally crystallized as a typical dolerite with trachytic labradorite laths but was soon altered by deuteric solutions to diorite. The plagioclase laths are finely clouded by fine dust and zoned from outside by clear new outer rims of andesine. All the pyroxene is altered into amphibole-biotite-pennenite aggregates. Mode : plagioclase 62, hornblendic amphibole 15, biotite 13, chlorite 4, opaques 5.5, and quartz 0.5. In spite

of the relatively high content of biotite and other deuteric replacements, radioactivity of this intrusion is low indicating that in this particular intrusion, introduced deuteric or hydrothermal solutions were not carrying significant amounts of radioelements.

Samples 24, 26 and 28 : All three composite samples come from the three parallel and rather similar spessartite intrusions cut by the brick red bostonitic dyke of sample 7 on Gebel el-Dirisa. Andesine laths, 2 to 0.6 mm. long, still retain evidence of subophitic or trachytic texture, pyroxene totally replaced by amphiboles (hornblende) and nut-brown biotite, the latter also arising to a small extent from the opaque granules. Rocks are fresh and accessory intergranular quartz is present. Apatite is frequent, sometimes in bent, folded or dismembered segments indicating some kind of movement before complete solidification of the intrusion. Apatite, with or without dark cores, does not seem to be an important source of radioactivity, for here it does not produce any visible halos in the biotite, unlike zircon and some peculiar unidentified tiny dark brown metamict rods in biotite. In sample 26, the broad andesine plates display peculiar schiller structure with tiny opaque rods arranged in two sets parallel to the cleavage planes of the lagioclase and are probably after the original schiller of pre-existing labradorite. Peculiar opaque rods are also frequent, disseminated throughout the whole rock and not only in the large euhedral andesine plates as in the other two samples. Modes for samples 24, 26 and 28 respectively are as follows : plagioclase 52.3, 57.5, 50.4 ; hornblende 21.2, 15.7, 13.4 ; biotite 16, 22, 24.4 ; chlorite 1, 2, 4.6 ; quartz 1.5, 1.2, 2.6 ; and opaques 5, 1.8, 4.6 (excluding the tiny rods). It is interesting to note that radioactivity also increases respectively ; the less basic dyke (No. 28) being the more radioactive.

Sample 25 : From the original neck-like quartz-diorite intrusion giving westward three to four distinct close dykes of the Old Golf Course. Andesine occurs in irregular plates and not in well defined laths, with some zoning. Apatite is most frequent. Small patches in the intrusion, as if of cognate xenoliths, are richer in biotite (*Z* sepia brown, almost black, *X* brownish yellow) in sub-trachytic arrangement. Mode : andesine 35, hornblende and uralite 33, biotite 17 (including 1.8 chlorite) and quartz 8. This is the least radioactive of the sampled diorites.

Sample 27 : From a diorite with some relics of pre-existing doleritic texture. Some plagioclase laths are bent, biotite (*Z* dirty olive brown, *X* pale yellow) apparently arises in part from opaque rods expulsed during the change of dolerite into diorite. Mode : andesine 56, actinolitic amphibole replacing pyroxene (?) 8, biotite 19, chlorite 7.7, opaques 9, and quartz 0.3.

Sample 29 : From a « mica-diorite » dyke at Mesitot. This dyke seems to be the westward extension of intrusion No. 25. However, it is poorer in quartz but richer in biotite (*Z* dark nut brown, *X* cream). Relics of doleritic texture in plagioclase laths. Ill-defined tufts of amphibole-chlorite aggregates, probably after pre-existing pyroxene, are largely replaced by biotite. Pentiful small apatite needles. Biotite with rare tiny halos around unidentified diminutive dark inclusions. Mode : andesine 55.5, biotite 23, amphibole-chlorite green tufts 14, opaques 7.2, and quartz 0.3.

Sample 30 : From a mica-hornblende-dioritic neck intrusion. Larger earlier porphyritic plagioclase laths are slightly bent and are set in a matrix in which the doleritic texture is subdued by these broad and stout andesine crystals. The latter are full of schiller inclusions of tiny opaque rods arranged parallel to the cleavage. The schiller structure seems to be after a pre-existing one in the older large plagioclase plates as the later smaller granular plagioclase plates in the matrix are mostly clear though sometimes enclosing small cores of old schillerized plagioclase. Biotite (*Z* dark red brown, *X* pale cream) has rather frequent tiny dark halos around unidentified spot-like inclusions. Mode : andesine 24, biotite 25.2, hornblende 20.8, chlorite (pennenite) after biotite 4, quartz 4, and opaques 4.

Sample 32 : From a strongly altered mica-diorite with relics of a typical doleritic texture. Most of the mica (biotite) and other ferromagnesian minerals have altered to green chlorite (pennenite) and epidote granules. Plagioclase laths are all clouded but still retain relics of a schiller structure, especially in their cores. Mode : andesine 48.5, chlorite (apparently after biotite) 31.3, altered and hydrothermally « washed » ferromagnesian (probably amphibolic) aggregates 8.9, relict biotite 2.1, altered opaques 8.5, and quartz 0.7.

Sample 33 : From an ill-defined neck-like dioritic intrusion. Relatively coarse-grained spessartite with texture recalling that of dolerite but the idiomorphic shape of the stout large andesine crystals is lost. These andesines, up to 2 mm. in diameter, are zoned with schillerized cores and outer clear rims. Biotite (*Z* dark brown or olive brown. *X* paler shades) has some tiny

dark pleochroic halos around unidentified dust-like spots. Unlike preceding samples, hornblende here is pleochroic in bluish tints. Plentiful needles and small prisms of apatite. Mode : andesine 39, hornblende 32, biotite 15, quartz 6.6, opaques 6.4, and chlorite 1.

D. — *The Kersantites* (*biotite-diorites*).

From the preceding description it will be seen that by deuteric alteration of intrusions of originally doleritic composition (e.g. No. 20) the dolerites changed into diorites, quartz-diorites and mica-quartz-diorites. Likewise, the dykes grouped here under kersantites are simple diorites in which the alteration of the original pyroxene and amphibole had been intensified so that much biotite was produced. A purely arbitrary limit of not less than 40 % modal biotite is taken to justify enlisting the rock as kersantite. Indeed, intrusion No. 35 is considered a kersantite while it probably belongs to the same intrusion as samples 25 and 29 considered as quartz-diorite and diorite respectively, simply on the merits of their biotite and quartz content. In kersantites, the alteration of hornblende and pyroxene to biotite is rather complete, and the presence of rare amygdules filled by quartz and biotite in sample 35 indicates that the action of volatiles and deuteric alterations was much stronger in this part of the intrusion than in parts of samples 25 and 29.

Kersantites are thus mica-diorites. The plagioclase is still andesine. Plagioclase laths show all textural features mentioned above : doleritic or trachytic with occasional porphyritic textures (pl. IV, B). Biotite with *Z* deep brown or olive-brown, *X* pale yellow, is variably altered to chlorite, and occurs as long thin decussate flakes, probably after pre-existing hornblende needles and prisms of which some relics sometimes still survive. Apatite is plentiful. In spite of the increased development of biotite in kersantites as compared with diorites, the former has a rather low radioactivity.

Sample 34 : Mode : andesine 50.8, biotite 39.5 (8.6 still showing relics of amphibole fibres), pennenite 2.1, opaques 7.1, and quartz 0.63.

Sample 35, pl. IV, B : Mode : biotite (with some chlorite replacements and relics of amphibole) 43.7, plagioclase 43.5, opaques 12.3 and quartz 0.5.

Sample 36 : Mode : biotite (with some chlorite and relics of amphibole and uralite) 48.7, andesine 44.2, opaques 6.4, and quartz 0.7.

Sample 37 : From a fine grained kersantite dyke on Biga Island. Biotite is lightly altered by tiny sericite wisps and by chlorite. Andesine forms about 52 % by volume of the rock. This kersantite dyke is cut by the camptonite dyke of No. 43.

E. — *The Camptonites :*

Just as the majority of the late minor intrusions of Aswan can be divided into two broad suites : acidic bostonitic group and another suite of basic basaltic derivation (dioritic lamprophyres, dolerite etc.) it appears similarly possible to classify alkaline intrusions into acid camptonites on the one hand and basic sodic camptonites or basic potassic kersantites on the other, with all transitions from their parental magma types.

The acid camptonites are perhaps better defined as transitional between true vogesites and true camptonites, and are characterized from the basic camptonites by their richness in silica, their relative lightness in specific gravity, by the occurrence of both potash feldspar and albite-oligoclase plagioclases, and by the kind of alkali amphibole. In the basic camptonites, the plagioclase is always andesine and in many cases there are transitional indications of having evolved from pre-existing olivine-dolerite intrusions by deuteric alkalic introductions.

The alkaline amphibole in the acid camptonitic dykes occurs in relatively large broad plates or in stumpy prisms moulded in the triangular or polygonal spaces between the alkali feldspar laths and plates (pl. V, A-B), $Z \wedge c = 15°$, $2V$ is quite small, pleochroic with *Z* in variable shades of green, olive green or bluish green, *Y* greyish brown, *X* brown, pale sienna or pale yellow. Sometimes this amphibole is zoned with outer zones of pale colours : *Z* pale green, *X* yellow or pale straw yellow. The alkali amphibole is probably barkevikite, slightly kataphoritic.

In the basic alkaline dykes, the alkali amphibole accompanying the andesine occurs by itself in slender long needles (pl. VI, A) or is seen

replacing the pyroxene or serpentinized olivine (pl. VI, B and VII, A-B). It has a larger optic angle compared with that of barkevikite of the acid dykes, $Z \wedge c = 13°$, and the pleochrism is also much different with Z nut or red brown, Y red brown, X pale cream. Prismatic crystals are frequently twinned parallel to their length. This amphibole is probably a barkevikitic variety different from that of the acid dykes.

The sodic camptonitic dyke of sample 43 cuts the kersantitic dyke of sample 37 on Biga Island. This might indicate that all camptonites of the area are relatively later than the kersantites and dioritic lamprophyres though this single observation may not be sufficient for generalization. Acidic lamprophyres (bostonites, solvsbergites) also cut the dioritic lamprophyres but direct evidence of their age relative to the camptonites is lacking.

Sample 38 : From a barkevikite-bearing bostonite dyke (pl. V, A-B). Alkali feldspar laths in typical trachytic texture, 0.8 mm. long. Both potash feldspar and acid oligoclase plates are present, the former mineral seems to have crystallized a little later or longer than the acid oligoclase and may form clear outer rims to the latter (pl. V, B) beside its independent intergranular crystals. The barkevikitic amphibole occurs in broad plates and stumpy crystals in the angular or polygonal spaces between the feldspar laths. Some such intergranular spaces are occupied by a residual granophyric or felsitic mesostasis. The importance of this intrusion is that it is the only one of its kind so far sliced that directly throws light on the much altered bostonite-solvsbergite suite of the district. It is relatively the freshest intrusion of the suite and its alkali amphibole may be similar to that of the elusive pyribole always found altered beyond recognition and pseudomorphed either by greenish or yellowish chloritic material or by iron oxides. Indeed in parts of this intrusion, the barkevikite is altering to hematite pseudomorphs much similar to those of the bostonitic suite described above. Mode : all alkali feldspars 80, barkevikite 9.2, opaques 10.2, and residual granophyric-felsitic matrix in small interstices 0.6. Apatite in small needles is a frequent accessory.

Sample 39 : From an alkaline amygdaloidal quartz-bostonite. On the whole this intrusion resembles the preceding one except that it is more solvsbergitic and contains some interstitial quartz. The alkali amphibole is almost entirely replaced by clear tiny fibrous chloritic tufts but the habit and outline of the pseudomorphs are similar to barkevikite of sample 38. Feldspar laths are clouded and some calcite occurs in tiny amygdules as well as in some interstitial polygonal spaces between the feldspar laths. Mode : total feldspar 81.5, chloritic pseudomorphs after amphibole 8, opaques 8.5, and quartz 2.

Samples 41 and 42, pl. VI, A : These two composite samples probably belong to the same dyke intrusion though collected from about one kilometre apart. In thin section, these elegant rocks are made up of well defined slender prisms and cross sections of the alkali brown red pleochroic amphibole haphazardly arranged with partly altered plagioclase (andesine). Tiny apatite needles are abundant. One tiny whitish needle of unidentified mineral (not zircon or apatite) causes a dark halo in the soda-amphibole. Average mode : feldspar 49.18, amphibole 47.17, opaques 3.65. Sample 42 is more altered in parts than sample 41 whereby the amphiboles become replaced by hematite pseudomorphs. It is less radioactive than sample 41. Thin sections indicate no relic of pre-existing pyroxene which alkali amphiboles might have replaced (as in samples 43 and 44 below). This intrusion seems to have thus crystallized directly as such from basalts or basaltic derivatives enriched with vapour and hyperfusibles containing water and alkalies.

Sample 40 : From a neck intrusion. It resembles samples 41 and 42 except that almost all the red brown amphibole prisms are replaced by hematite dust and the rock is rich in tiny apatite needles, sometimes arranged in herring-bone structures. Hand-specimens indicate flow banding with bands of slightly different colours.

Sample 43, pl. VI, B : This intrusion probably crystallized originally as a typical fine grained dolerite dyke with few porphyritic olivine crystals. It was then attacked by an influx of deuteric alkaline siliceous solutions whereby all olivine was replaced by yellowish to brownish serpentine pseudomorphs and the small stumpy augite crystals were partly replaced by the alkali red brown amphibole which also forms at the outer borders of the serpentine. New hydrothermal alterations to carbonate and iron oxides also occur. In the same thin section, all three kinds of alterations are seen to be more augmented in certain patches than in others probably depending upon proximity to sites of entrance of the deuteric residua. Mode : basic andesine 36, augite 24.12, alkali amphibole 25.19, serpentine (after olivine) 7.61, and opaques 7.08. Chief accessory is apatite.

This dyke cuts the kersantitic dyke on Biga Island (No. 37).

Sample 44, pl. VII, A-B : From a camptonitic dyke on El-Hesa Island, much resembling the preceding Biga Island (No. 43) except that it was originally somewhat richer in olivine and the larger augite crystals are oscillatorily zoned. It is also less altered and of somewhat coarser grain. Olivine is entirely pseudomorphed by yellow-brown serpentine, tremolite-actinolite tufts and carbonates which occur interstitially between the plagioclase laths (basic andesine). The sodic amphibole partly replaces the pyroxene and serpentine pseudomorphs but some of its small prisms appear to grow by themselves in the matrix. Apatite is frequent but in very tiny needles. Mode : plagioclase 40.8, pyroxene 28.28, pseudomorphs after olivine 10.95, soda amphibole 13.26, and opaques 6.17.

Late Minor Intrusions of the Qoseir District

A. — *Bostonite-solvsbergite suite :*

Of the following 18 composite samples, the first three and No. 50 approach true bostonites, being richer in potash feldspar laths and almost devoid of original pyriboles. The rest are solvsbergitic. Compared with their Aswan equivalents, apatite is a rather less frequent accessory in these Qoseir intrusions.

Sample 45 : From a fresh greyish white bostonite dyke made up almost entirely of small alkali feldspar (albite-orthoclase) laths, 0.2-0.4 mm. long, in typical panidiomorphic trachytic texture, in parts showing subparallel flow arrangement and occasional porphyritic feldspars. Approximate mode : alkali feldspar 96, quartz 3, and tiny accessories, sericite and opaques 1. Apatite is rather scarce among the accessories but definite tiny striated and zoned-like zircons occur as well as a frequent unidentified yellowish high relief mineral in very tiny granules. This dyke has a comparatively high radioactivity (eU = about 19 ppm.). In appearance, it is identical microscopically with the clear areas in pl. I, B.

Samples 46 and 47 : Both samples are taken from the same dyke, which also resembles the preceding one (No. 45) except that sample 46 is partly altered and hematitized along fracture cleavages and jointing (pl. I, B) while sample 47 is from a thoroughly stained yellow brown part of the same intrusion and contains much more hematite dust. The radioactivity decreases steadily with increase in these alterations from samples 45 to 46 to 47. Feldspars in the last two samples are lightly clouded and with some tiny sericite.

Samples 48 and 49 : From a brick red quartz-bostonite dyke with lightly clouded albitic laths, 0.8-0.3 mm. long, sericitized and stained red from hematite particles. All pyriboles are altered to hematite. Mode : alkali feldspar 75.5, quartz 13.3, opaques and opaque pseudomorphs 11.2. Both samples come from the same intrusion : sample 49 is from the more altered parts and is less radioactive than sample 48 which is nevertheless the second most radioactive late intrusion (eU = 24.24) in the studied samples both from Qoseir and Aswan.

Sample 50 : From a rather fresh-looking massive dyke of light pink colour. Microscopically the groundmass consists of a homogeneous mosaic of alkali feldspar laths (average length 0.25 mm.), moderately sericitized. Mosaic is spangled with few large stumpy porphyritic crystals of the same feldspar (average diameter 2 mm.). Quartz is less frequent. Ferromagnesian constituents must have originally been very small and are now entirely replaced by hematite pseudomorphs. A film of intergranular hematite dust occurs lightly between the feldspar laths. In the groundmass, there is a suggestion of micrographic or symplekitic growth in some grains. This is the most radioactive of all samples studied (eU = 24.45 ppm.).

Sample 53, pl. VIII, B : From a buff coloured bostonitic dyke made up of slender laths of alkali feldspar, up to 0.8 mm. long, in parts with flow and fluxion structures. The feldspar is highly clouded with disseminated hematite particles and is slightly sericitized. All original pyriboles are replaced by hematite.

Samples 51, 52, 54, 55, 56, 57, 58, 59 and 60 : Are all rather similar (pl. VIII, A) but differ in minor details and degree of alteration. Sample 59 comes from a massive fine-grained brick-red quartz-bostonitic dyke. The albitic laths, 0.2 mm. long, are in subparallel flow arrangement and dyed red by disseminated hematite dust. Original opaques and pyriboles, now replaced by hematite, were originally relatively few. Sample 60, pl. VIII, A, comes from a dark buff-coloured quartz-bostonitic dyke. Albitic laths, 0.1-0.3 mm. long, in typical trachytic panidiomorphic texture with quartz and chlorite relics of alkali pyriboles in triangular and polygonal spaces between the feldspar laths. Average mode : feldspar 82, quartz 9, ferruginous and chloritized relics 9, with few calcite, hematite, and apatite grains. Feldspar laths are stained red by hematite dust especially along their outer margins.

Sample 61, pl. IX, A : From a much altered coarse quartz-bostonitic dyke. Albitic laths are sericitized and strongly stained with hematite, especially along their outer borders. Mode : feldspar 67, quartz 11, opaques and chlorite pseudomorphs after alkali pyribole 12. Some apatite and secondary calcite are accessories. Few tiny amygdules filled by calcite and idiomorphic quartz, with hexagonal cross section.

Sample 62 : From a much altered fine-grained red quartz-bostonitic dyke, near the northern foot of Gebel Hamadat. The dyke is strongly amygdaloidal with amygdules and vesicles pronoucedly elongated parallel to the extension of the dyke and containing quartz or groups of spherulitic zeolites. Sometimes the zeolites occupy the centre of the amygdule with an outer margin of quartz. Albitic laths are so strongly sericitized and stained red that they are rendered opaque. All pyriboles are replaced by hematite. This is the most altered, leached and weathered bostonitic dyke from Qoseir and it is also the least radioactive of the Qoseir bostonitic suite.

B. — *Minor miscellaneous odd dyke intrusions of Qoseir :*

Unlike the preceding abundant bostonitic dyke swarms, the following 10 dyke intrusions occur only in the country rock of the composite granitic-quartz-dioritic diapirs of the Qoseir district and were not seen to cut them or the quartz-veins and « dykes» which may be taken to represent the latest hydrothermal phases or manifestations connected with the intrusion of the diapirs. Some of these minor intrusions, especially the dolerites and trachytes may even be pre-deformation, pre-granitic, while others may be post-deformation, syn-or-post-granitic.

Samples 63 and 64, pl. XI, A-B : Come from two of the buff to light coloured pink or orange aplite-like intrusions of which a dozen occur exposed in the dark slaty and greywacke country rock south of the Qena-Qoseir road between Bir Beida westwards till the coastguard station near the Duwi Mines. Thin sections reveal porphyritic crystals of quartz and highly sericitized oligoclase in a fine granophyric to feslitic quartzo-feldspathic matrix with some hematite granules and wisps of chlorite and sericite. The porphyritic crystals are bent and fractured (probably by collision during flow). Both the coarse quartz and oligoclase porphyritic crystals may serve as nuclei for a later spherulitic phase of crystallization of the magma. Approximate mode : porphyritic acid plagioclase 23, porphyritic quartz 7, matrix with spherulites

70 (roughly 55 plagioclase, 40 quartz and 5 % hematite and chlorite). The intrusions may be called porphyritic spherulitic quartz-porphyrites. Their granodioritic affinities may indicate their connection with the quartz-diorite-granodiorite diapirs of the area, representing their aplitic satellites and thus would not be elegible for inclusion with the dykes studied here.

Sample 65 : From a pale pinkish, hard, massive dyke. Granular quartz-feldspathic matrix (average diameter 0.3 mm.) is rather rich in quartz (exceeding 50 % of its mode) with relatively few porphyritic plagioclase. All feldspars are lightly altered and take a hematitic stain which also fills some fractures. Some of the hematite-veinlets have a zig-zag stylolitic-like nature. Original ferromagnesian minerals must have been rare.

Sample 66 : From a hard massive buff-grey dyke of a tonalitic character. Feslitic matrix with prismatic feldspar and tiny accessory ferromagnesian minerals entirely altered to hematite pseudomorphs and rare chlorite. Several porphyritic crystals of plagioclase (not exceeding 0.5 mm. in length) and partly resorbed quartz occur in the matrix.

Sample 67, pl. IX, B and pl. X, A-B : From a dyke intermediate between a minette and a kersantite, observed in the country rock south of Wadi Ambagi and northeast of the northern end of Gebel Atshan (indicated as minette on the Geological map, Gindy, 1958, Plate I). It is a thoroughtly weathered, peculiar looking dyke consisting of tiny glistening bronze mica flakes causing it to look very much like a vermiculitic skarn. In the field, this dyke seemes to occupy a slickensided fault surface and looks somewhat sheared and slickensided itself. Thin section reveals the rock to be roughly made up of leached biotite 50, strongly sericitized and clouded potash and soda feldspars 23.5, quartz with undulose extinction 13.3, and opaque-goethite granules 13.2. Tiny microscopic quartz-calcite veinlets traverse the thin section. Biotite was probably of the titaniferous « hornfels» type with $Z = Y$ red brown, X pale yellowish brown, and occurs in thin long haphazardly arranged flakes. It is much cleaved and replaced by prehnite and signs of shearing are indicated by microsocopic folding of some of the biotite flakes (pl. IX, B). Scarce apatite needles cause no sensible dark halos in biotite which is, however, relatively rich in dark halos caused by black metamict inclusions. It is interesting to note that only where such intense halos occur in the biotite, does the latter alter by release of tiny brown or opaque needles arranged in three equally dispersed sets and radiating from the metamict centre (pl. X, A-B); probably

because of the breakdown of the atomic bonds there by the alpha bombardment causing the biotite to alter readily. The tiny rods and needles are yellowish in reflected light and may be reticulate rutile (sagenitic) needles or iron-oxide needles released along weak intermolecular directions like those of the six-rayed « pressure or percussion » figures.

The rather low radioactivity of this intrusion, in spite of indications of former higher radioactivity, may be explained by the leaching away of most of the radioelements in this sheared dyke (unless the halos were « extinct halos » produced by the short-lived nuclides of the uranium family deposited from hydrothermal fluids moving through the sheared dyke, see K. Rankama, 1954, Isotope Geology, Pergamon Press, London, p. 128). This dyke may have been of any Pre-Cambrian age : pre-tectonic, pre-granitic, syntectonic syngranitic, post-tectonic syngranitic or even post-tectonic, post-granitic being sheared in late epeirogenic and fault-settling episodes.

Sample 68 : From a massive fine-grained olive green, highly altered dyke cutting the Eparchaean conglomerates of Wadi el Kareim. It consists of a fine quartzo-feldspathic mosaic rich in chlorite wisps. It might have originally been a trachyte, like sample 69 but of different texture.

Sample 69 : From a massive fine-grained violet trachytic dyke cutting Eparchaean siltstones in Wadi el-Kareim. The alkali feldspar laths, 0.4-0.3 mm long, are much clouded, in parts almost opaque, with typical trachytic texture. All ferromagnesian minerals are replaced by chlorite. Rough mode : altered feldspar 66, chlorite and opaque granules 34. The dyke was probably a trachyte originally.

Sample 70 : From a buff coloured, sheared and foliated fine grained dyke made up of strongly altered granular mosaic of albite, opaque granules, tiny chloritized biotite and sericite wisps. It looks like an intensely metamorphosed and altered intermediate intrusion in the slates opposite the Duwi Mines, south of the Qena-Qoseir road. It might have been a pre-granitic minor intrusion but its original nature is doubtful.

Samples 71 and 72 : These two composite samples come from two prominent straight dark green dykes in the lowly metamorphosed greywackes, microbreccias and conglomerates opposite the Duwi Mines. Although apparently not bent or sheared, they might have been pre-granitic in age. They display

typical doleritic texture but are much altered and are now made up of pseudomorphs of chlorite, calcite, saussurite with accessory ilmenite, sphene, and rare late quartz.

IV. — TECHNIQUE USED AND RESULTS

Each of the composite samples, collected and aggregated in the manner described, were crushed together in a clean steel mortar to small fragments which were then quartered to about 50 grams. This fraction was then ground in a clean agate mortar to a fine powder. About 15-20 grams of this powder were then transferred to small clean specially labelled cylinderical plastic boxes with tight plastic covers. Precaution was taken against contamination from the different samples; all mortars and handles were thoroughly cleaned before each operation. The powdered samples were left in the closed boxes for no less than two months to restore radioactive equilibrium upset by the release of some radon or thoron during the crushing and grinding operations. Then Ilford « nuclear research photographic plates » of the C. 2. type of emulsion (sensitive to protons to approximately 50 Mev., *i.e.* to alpha radiation but not to beta or gamma radiation), emulsion thickness of 100 microns, were cut under safelight by a diamond pencil into small squares each with a surface area of about 2 cm^2. The number of each sample was then engraved on the glass side of the square and each square was put, emulsion-side downwards, opposite the corresponding powdered sample in the small plastic boxes. Each square was gently pressed into the fine rock powder and the plastic cover was replaced. All boxes were then stored in large tin boxes with $CaCl_2$ desiccators to guard against fading of latent alpha track images in the humid climate of Alexandria. The boxes were shut away in a light-tight dry cold container for a definite period of exposure ranging from 20 to 30 days. At the same time, blank squares from the same patch of nuclear plates were stored similarly as monitors. After the exposure, the squares were taken off and gently cleaned from adhereing rock powder; each square being cleaned by a different clean soft cloth. The square plates were developed, hardened and fixed following the instructions of Ilford Ltd. (1958).

Each square was mounted on the mechanical stage of a « nuclear research microscope » kindly lent by Mr. A. I. Ghozlan. Using a magnification of 600 and oil immersion objective, alpha tracks recorded in the emulsion of the square plate were then counted in several traverses. From the knowledge of the number of alpha tracks recorded per scanned area, time of exposure and the correcting factor, the *specific activity of the sample* can be calculated. This is the number of alpha particles emitted from a square centimetre per second from the flat surface of the powdered rock. The specific radioactivities of the 72 samples are given in the second column of table 1. Alpha tracks produced from disintegration in the glass backing of the plates or inside the gelatin emulsion itself can be easily distinguished from those emitted by the rock as the former tracks do not originate from the outer upper surface of the emulsion. Cosmic « stars » and single tracks caused by cosmic radiation can be distinguished by their different character and by the fact that single cosmic tracks traverse the whole thickness of the gelatin emulsion.

Since no measurement of individual track lengths was carried out, the amounts of thorium and uranium present in the samples cannot be calculated. Senftle and Keevil (1947) statistical work showed that in acid and intermediate igneous rocks, the ratio of ThO_2 to U_3O_8 varies from 3 to 4; in granites and granodiorites it is near 3. On this basis it would have been possible to roughly calculate the thorium and uranium content of the acidic minor intrusions. However, in our present intrusions, such calculations would probably be unjustified and misleading since there is overwhelming indication of strong deuteric and later hydrothermal activity of gases, volatiles and fluxes, as well as oxidizing conditions whereby differential leaching and selective deposition and adsorption, particularly of uranium, would most certainly be active. All these factors would seriously upset and change the initial Th/U ratios of the minor intrusions. Assuming that radioactivity is produced entirely by uranium and that this uranium is in equilibrium with its daughter products, the *equivalent uranium content* (eU_3O_8 or simply expressed as eU) of the samples *i.e.* the equivalent amount of uranium in equilibrium with its daughter products which emit alpha particles equal to those emitted by the rock sample, can be directly calculated from the specific corresponding activity

of each rock sample using equations for thick sources, e.g. those given by Yagoda (1949, p. 162-163). These formulae require knowledge of the range of alpha particle tracks of minimum discernibility in the emulsion and of the « permeability or stopping power » of each sample. The former value can be directly obtained during track counting but the calculation of the latter requires complete chemical analysis of each sample or mixing a powdered solid of known permeability with an equal weight of the powdered rock sample and calculating the permeability of the latter from the specific activities of the powdered rock and the mixture. Since neither procedure was carried out, the permeability of the different samples was roughly calculated from the average modal mineralogical analysis of thin sections from each sampled intrusion. It is believed that eU values calculated by this method will not deviate greatly from values calculated by the other more accurate methods mentioned.

The resulting equivalent uranium content was multiplied by a factor of 1.15 (about 15 %) to compensate for the decrease caused by back-scattering of alpha particles, any vertical alpha tracks missed during counting, and the approximations used in the Bragg-Kleeman equation (Yagoda, 1949, p. 164). The final (eU) values expressed in parts per million of the rock for the different samples are given in the third column of Table 1. The equivalent thorium content would be roughly 3.2 times that of the corresponding eU values.

According to Bowie (1954, p. 62) the statistical error involved in all assay techniques depending on counting alpha tracks is likely to be considerable for, apart from the important sampling error, other sources of error involve (1) difficulties in recognizing alpha tracks which dip into the emulsion at high angle, (2) equilibrium disturbances, (3) differences in surface diffusion, (4) variations in the effective stopping powers of mineral species, and (5) fading of latent images in exposures of long duration. Such errors would tend to be large in rocks of low radioactivity such as the diorites, dolerites and kersentites etc. studied here. However, in spite of these pitfalls, and the several approximations used, special precautions were taken to minimize errors, and very interesting and consistent results emerged. These are discussed in the next section.

TABLE 1. — Specific Activity, Equivalent Uranium Content, Specific Gravity and Degree of Alteration of Sampled Late Minor Intrusions from the Aswan and Qoseir Districts [1].

ASWAN INTRUSIONS

Sample Number	Specific Activity × 10^{-6}	eU p.p.m.	Specific Gravity	Degree of Alteration
1	274.88	3.0	2.533	S.A.
2	262.07	2.87	2.557	P.A.
3	333.66	3.47	2.591	P.A.
4	799.10	8.16	2.649	A.
5	1511.30	15.40	2.524	S.A.
6	876.0	9.10	2.578	P.A.
7	1277.0	13.05	2.563	P.A.
8	319.0	3.30	2.744	P.A.
9	640.0	6.56	2.640	A.
10	417.60	4.41	2.566	A.
11	584.0	5.96	2.557	A.
12	565.0	5.65	2.591	A.
13	597.40	6.0	2.658	M.A.
14	462.60	4.71	2.567	A.
15	507.82	4.16	2.661	A.
16	298.80	3.11	2.663	M.A.
16 A	554.35	5.99	2.608	P.A.
17	401.30	2.71	2.664	P.A.
18	472.17	3.21	2.666	P.A.
19	507.0	5.17	2.685	P.A.
20	208.0	2.60	3.035	F.
21	303.0	3.39	2.970	S.A.
22	290.0	3.66	3.014	F.
23	180.0	1.90	2.858	S.A.
24	156.0	1.88	2.922	F.
25	145.22	1.64	2.908	S.A.
26	287.04	3.65	2.917	F.
27	352.17	4.53	2.957	S.A.
28	470.43	6.02	2.955	F.
29	181.74	2.04	2.946	F.
30	274.25	3.48	2.902	F.
32	208.0	2.22	2.910	A.
33	194.02	2.52	2.918	S.A.
34	245.43	3.12	2.917	P.A.
35	137.51	1.46	2.936	S.A.
36	246.0	3.13	2.812	F.
37	221.0	2.80	2.790	S.A.
38	400.0	4.05	2.662	P.A.
39	439.73	4.35	2.744	M.A.
40	464.87	4.69	2.749	A.
41	424.30	4.62	2.858	S.A.
42	283.24	3.16	2.915	F.
43	252.65	3.37	2.918	F.
44	309.65	3.94	2.849	S.A.

QOSEIR INTRUSIONS

Sample Number	Specific Activity × 10^{-6}	eU p.p.m.	Specific Gravity	Degree of Alteration
45	1726.0	19.10	2.537	F.
46	1457.0	16.14	2.518	P.A.
47	1207.0	13.42	2.584	A.
48	2180.0	24.24	2.578	P.A.
49	2125.0	23.61	2.580	A.
50	2199.0	24.45	2.526	P.A.
51	1096.14	12.19	2.5266	P.A.
52	1776.48	19.76	2.5311	P.A.
53	1309.0	14.25	2.521	A.
54	1269.0	17.12	2.550	P.A.
55	1041.20	11.58	2.548	P.A.
56	937.38	10.43	2.526	P.A.
57	780.48	8.68	2.588	A.
58	768.76	8.55	2.523	A.
59	1349.0	15.0	2.530	A.
60	761.0	8.30	2.641	P.A.
61	901.0	10.10	2.669	M.A.
62	605.0	7.0	2.503	M.A.
63	760.0	8.53	2.583	P.A.
64	633.0	7.18	2.597	P.A.
65	483.84	5.45	2.641	S.A.
66	238.95	2.70	2.714	S.A.
67	565.0	6.30	2.742	M.A.
68	151.89	1.77	2.798	M.A.
69	1307.0	14.20	2.625	P.A.
70	402.0	4.37	2.580	M.A.
71	263.0	2.70	2.946	M.A.
72	226.0	2.36	2.839	M.A.

[1] 1. Abbreviations used to describe the degree of alteration :
F : fresh, S.A. : slightly altered, P.A. : partly altered, A : altered, M.A. : much altered.

2. *The Aswan Intrusions :*
Samples 1- 3 are from granophyres and fluidized intrusions.
4-19 bostonite-solvsbergite suite.
20-33 dioritic lamprophyre suite.
34-37 kersantites.
38-44 camptonites.

3. *The Qoseir Intrusions :*
Samples 45-62 are from the bostonite-solvsbergite suite.
63-66 granophyres and felsites.
67-72 miscellaneous Pre-Cambrian intrusions of doubtful placing in the history of the aera.

See text for details of the petrography of sampled intrusions.

Specific gravity of sampled rocks are given in the fourth column of Table 1, and were determined either by differences in weight of samples in air and in water or by the picnometer on granulated specimens. The abnormally low values of specific gravity of some acid samples given by these methods may be largely due to the «porous» or vesicular nature of the original intrusions themselves as witnessed by thin sections and perhaps in part also to later hydrothermal leaching and alterations rendering the rocks somewhat «porous» and lighter. The degree of alteration of each sampled intrusion is given in the last column of Table 1.

V. — RADIO-PETROGENETIC DISCUSSION

1. *The relation between the radioactivity and the composition of the minor intrusions :*

It is well established now that the average acid igneous rocks, rich in silica, are more radioactive than the average basic ones, while in intermediate igneous rocks, the radioactivity is erratic; alkaline varieties always tend to be more radioactive than their calc-alkaline equivalents (e.g. see Larsen and Phair, 1954, p. 77-84; Birch, 1954, tables p. 156-157). Parallel results are also obtained here (Table 2) but as no chemical analyses were carried on the Aswan and Qoseir samples, the specific gravity of these samples, coupled with the knowledge of their mineral constitution, were taken as an approximate measure of the relative basicity of the minor intrusions.

A plot of the specific gravities against the specific alpha radioactivities of these minor intrusions (Fig. 1) or against their eU contents (Fig. 2) gave distribution figures remarkably similar in their broad features to those given by Larsen and Keevil (1947) or Larsen and Phair (1954, p. 83) for igneous rocks of the Southern California Batholith (uranium or equivalent uranium contents plotted against Larsen's index of the composition of rocks), despite the fact that we are here dealing with small minor intrusions that had probably evolved by several different mechanisms. Plots of the acid and intermediate intrusions here (bostonites, solvsbergites, granophyres and felsites) show a wide scatter

TABLE 2. — Summary and Average Radioactivity of Sampled Intrusions (expressed in eU contents p.p.m.).

Rock Type	Average eU	Minimum eU	Maximum eU	Number of composite samples
Aswan Intrusions :				
«Granophyres» etc.	3.11	2.87	3.47	3
Bostonite-solvsbergite suite	6.274	2.71	15.40	17
Camptonite suite	4.03	3.16	4.69	7
«Kersantite» suite	2.63	1.46	3.13	4
Dolerite-diorite suite	3.04	1.64	6.02	13
Qoseir Intrusions :				
«Granophyres» etc.	5.96	2.70	8.53	4
Bostonite-solvsbergite suite	14.66	7.0	24.45	18
Altered trachytes	3.07	1.77	4.37	2
Altered intermediate dyke of doubtful origin (trachyte?)	14.20	—	—	1
Leached minette-kersantite	6.30	—	—	1
Altered dolerites	2.53	2.36	2.70	2
Granitic Rocks :				
Coarse Aswan Granite	7.58	—	—	15
Qoseir Granodiorites	12.72	—	—	10
«Average Granite» [1] (for comparison)	8.0	—	—	—

[1] After Larsen and Phair (1954, Table p. 87).

in the diagrams of fig. 1 and 2 but there is a remarkable rise in radioactivity over the extreme acidic ends (acidic intrusions of samples 5, 7, 45, 46, 47, 48, 49, 50, 52, 53, 54 and 59) where the highest maximum values for each area are attained. The lowest minimum values are towards the basic end (samples 20, 21, 23, 24, 25, 30, 32, 33, 34, 35, 71 and 72) where dolerites (and diorites and kersantites after them) occur. The diagram of fig. 2 is rather similar to that of fig. 1, the differences being due to variations of the «permeabilities» of the different samples

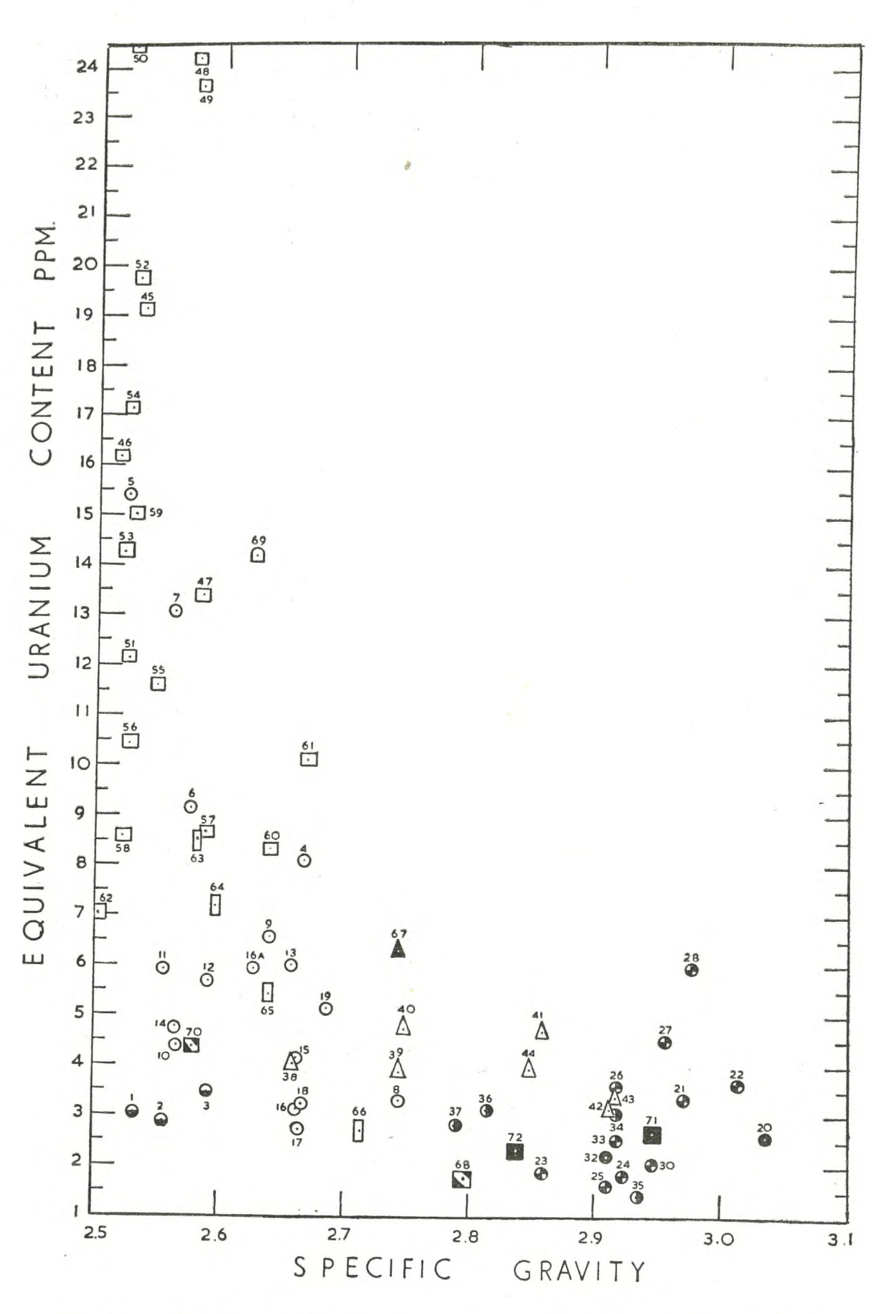


Fig. 2. — Distribution of equivalent uranium content of the sampled minor intrusions plotted against their specific gravities. Signs as in fig. 1.

to alpha radiation when calculating the equivalent uranium contents from corresponding specific activities of individual intrusions.

Among the minor basic intrusions of Aswan, alkaline varieties like the camptonites and some of the kersantites, or those just showing alkaline tendencies like olivine-dolerites having their pyroxenes and serpentinized olivines partly replaced by some late barkevikitic growths (e.g. samples 43 and 44, pl. VI, B and pl. VII, A-B) are relatively higher in their radioactivity than the corresponding basic non-alkaline types. Consequently in figs. 1 and 2, the plotted positions of the camptonites and minette intrusions (represented by triangles) occupy higher positions marking the upper boundary limit in the distribution of data over the range of intermediate to basic compositions.

With few exceptions, possibly due to late stage hydrothermal leaching, the most alkaline acid dykes of Aswan and Qoseir (true bostonites) are also the most radioactive of all late minor intrusions. Although Coulomb et al. (1958, p. 16) consider it unnecessary, several authors e.g., Larsen and Phair (1954, p. 88), Adams (1955, p. 81) showed that there is a corresponding increase of uranium with potash (and alkali content in general) in igneous rocks. This covariation of uranium with potassium was explained by Adams (1955, p. 80-81) in the Lassen Peak volcanics as a reflection of the exclusion of these two elements from common minerals formed during earlier stages of crystallization (because of their large radii and coordination numbers). Vistelius (1958), however, showed that in these volcanics, at least the concentration of uranium was not correlated geochemically with the process of fractional differentiation but was regulated by the migrations of uranium through the magmatic basin and its detention by the medium enriched with potassium. Something of this nature appears to have occurred in some of the Aswan alkaline basic dykes relatively enriched both in K (some of the biotite-diorites and kersantites) or Na (camptonites), see No. 3 below.

2. *The relation between the radioactivity and the alteration of the minor intrusions :*

There are of course all degrees of gradations between alterations due to ordinary weathering and those due to original hydrothermal deuteric

alterations and autometamorphism. Disregarding the effects of ordinary weathering (though they may be important where close jointing has strongly developed in the dykes) there is much impelling proof of the existence and strong influence of original gaseous, volatile and hyperfusible constituents in the making of most of these rocks in the near-surface quasi-volcanic conditions that must have prevailed. These are :

(*a*) The frequent presence of vesicles, amygdules and amygdales in these late minor intrusions, as well as intergranular or interstitial cavities between the feldspar laths themselves. These also account for the abnormally low specific gravity of some samples (figs. 1 and 2, and table I).

(*b*) The peripheral alteration of pyroxenes and serpentinized olivines to alkali amphiboles in the dioritic lamprophyres (pl. VI, B and pl. VII, A-B), the ferruginous introductions of hematite dust and alterations and staining of the feldspar laths (pl. I, A-B, pl. III, A and pl. IX, A), the destruction and oxidation of the alkali amphiboles in most members of the bostonite-solvsbergite suite in both Aswan and Qoseir into pseudomorphs of iron-oxide aggregates : all these features point to strong deuteric, hydrothermal and fugitive activities. The acidic suite of late minor intrusions are almost always more intensely altered than intrusions of the basic suite indicating a more important share taken by the volatiles and vapours in the genesis of the acid members.

That these late intrusions could have been subjected to more than one draft or episode of upsurging gases and volatiles during or after their solidification is shown in the development of fresh and clear albitic mantles to strongly altered and hematitized (almost opaque) cores of feldspar laths in some dykes (e.g. pl. VIII, A) as well as the development of new biotite. Neogene or intermittent volcanism could liberate hydrothermal solutions and vapour at more than one episode and these could climb up and attack, partially altering, pre-existing solidified intrusions at more than one episode, either lowering or elevating their newly formed mineral assemblages.

(*c*) The frequency of interstitial calcite and carbonates, sometimes also zeolite or chlorite in some camptonites and solvsbergites (e.g.

samples 43 and 44). El Shazly (1954, p. 18-19) reported fluorite, and fluorite replacing feldspar in two of the late Aswan minor intrusions.

(*d*) Highly altered dykes may cut older but fresher dykes indicating that there is no age relation between the degree of alteration and date or order of intrusion, e.g. the red bostonite dyke of pl. III, A cuts three fresh dioritic lamprophyre dykes on Gebel el Dirisa, northeast of El Shellal, Aswan.

(*e*) The evidence of fluidization, gas-granulation, gas-fluxing and melting in the genesis of certain granophyres and other devitrified dykes (Gindy, 1959).

The effects of such hyperfusibles, volatiles and hydrothermal solutions on the radioactivity of these intrusions are tremendous for, besides carrying away the radioelements from one place or level to another by oxidation and leaching they can precipitate them elsewhere should physical or chemical changes occur. The rather low radioactivity of the minette-kersantite dyke of sample 67, despite indications of abundant halos in the biotite, can be adequately explained by the strong hydrothermal leeching to which that dyke was subjected following its strong tectonic shearing. Its biotite was altered to prehnite and vermiculite, and the feldspars were strongly clouded. If the original radioactive material was in an easily soluble form (e.g. metamict) or could be easily oxidized, uranium could be easily leached and carried away.

The increased radioactivity of *basic dykes* when their pyroxenes (and olivines) are peripherally replaced by lately introduced intergranular sodic amphiboles (in camptonites) and by biotite (in diorites and some kersantites) is very instructive. The normal fresh dolerite or dioritic intrusions of Aswan (samples 20 to 37) are usually the least radioactive of all late minor intrusions there (except some members of the granophyric and fluidized suite, explained later), see table II. The dolerites solidified directly from a « normal » basaltic magma, and, as usual, are least radioactive but the fact that some of the fresh diorites are equally least radioactive would indicate that though such intrusions solidified from « wet» basaltic magmas containing water vapour, fluorine (for apatite, fluorite) and some alkalies, and allowing hornblende to crystallize

10.

instead of pyroxene, no appreciable radioelements were originally present in such wet basic magmas or were « fixed» primarily therefrom. This is also noticed in some more advanced cases in the kersantites (fig. 3) where pyroxene and hornblende are attacked and almost entirely replaced by biotite. However, in *some* kersantites and diorites and in *all* cases of late alteration of pyroxene and olivine to sodic amphiboles (e.g. in camptonites of samples 43 and 44, (pl. VI, B and pl. VII, A-B) or of the latters' direct crystallization (or recrystallization) from basaltic magmas relatively rich in water and soda (samples 39 to 41, pl. VI, A), there is a relative increase in radioactivity.

This observation is parallel to that of Davis (1947, p. 693) and of Davis and Hess (1949, p. 865, 869-870) that the radioactivity of ultramafic igneous rocks is virtually introduced with the late stage minerals like serpentine, tremolite, talc and kaemmerite. These late stage autometamorphic alterations and minerals are believed by Davis and Hess to have been formed by the concentration of volatile constituents in the residual magmatic solutions in the normal course of crystallization of the rocks, and in the Aswan basic intrusions, these late stage minerals and introduced ingredients, including the radioelements, might have been largely derived from original contamination or leaching by fugitive constituents from pre-existing radioelements in the host rocks.

As outlined in the petrographic section, there are all visible transitional stages of the change over from dolerites to diorites and of the latter to kersantites by the increase of the amount of biotite replacing the pyriboles and by the change from labradorite into andesine (sometimes slightly sericitized). As just mentioned here, the influx of K and Na required for these changes seemes to have been accompanied by an appreciable increase in radioactivity (fig. 3). Fig. 3 is rather interesting for, strangely enough, when the newly developed biotite exceeds a certain limit as in the kersantites, the radioactivity seems to decrease somewhat as if part of the introduced radioelements is again mobilized and on the move. Thus the increase in biotite should not automatically be taken as entailing an increase in the radioactivity of the rocks concerned. It should not be considered as the chief carrier of the radioelements. This simply means that the late hyperfusibles and residual solutions which had introduced

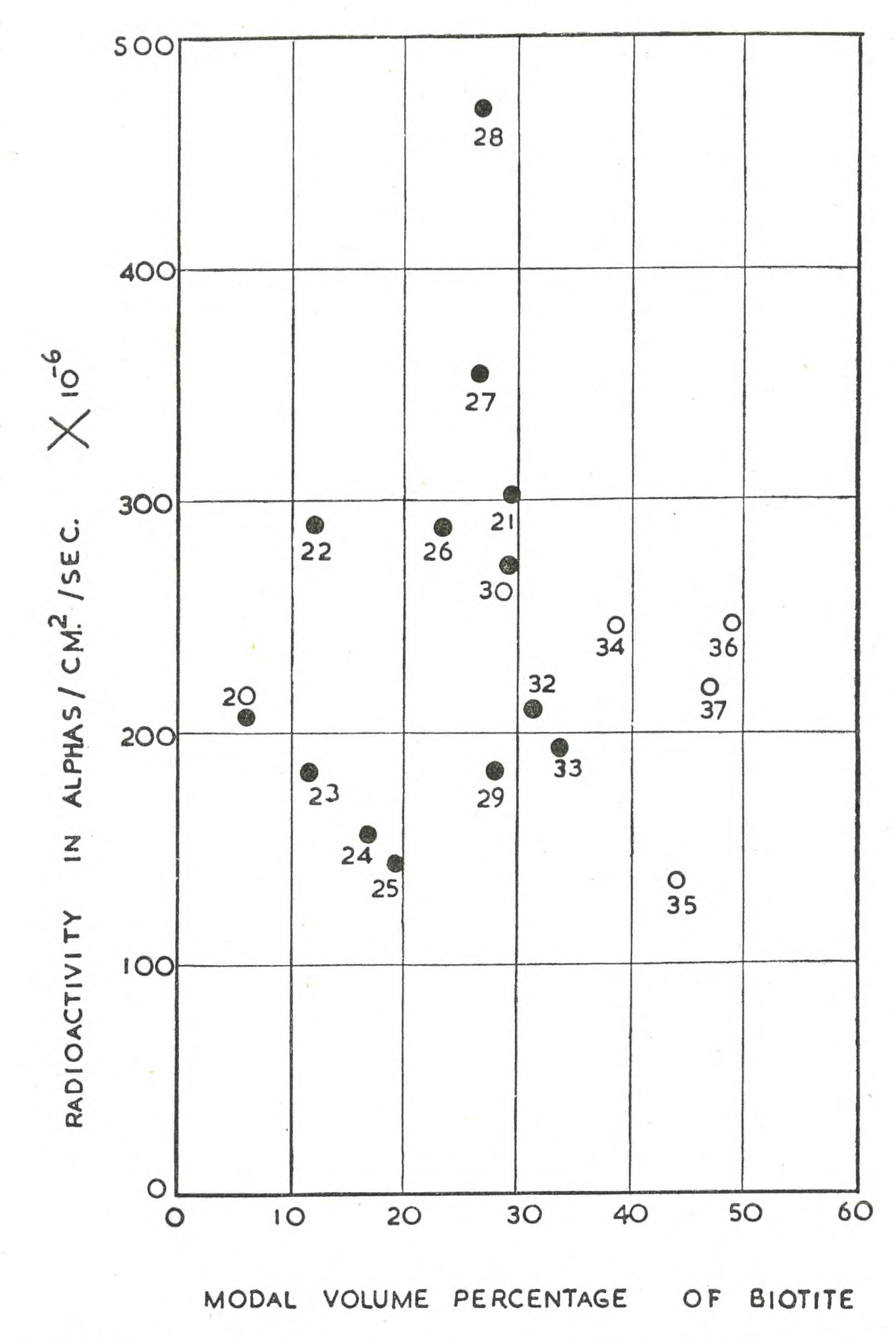


Fig. 3.— Distribution of alpha radioactivity (specific activity) of the dioritic lamprophyres (solid black circles) and kersantites (open circles) of the Aswan district plotted against their biotite contents.

the K and hydroxyl for the production of biotite, had often, though not always, introduced the bulk of the radioelements as well. That this was not always necessary or proportional, is indicated by the wide scatter of data in fig. 3 despite the fact that all the samples were relatively fresh. Thus samples 25, 29 and 35 which most probably belong to one long dyke intrusion, had, despite their wide petrographic differences, significantly low though somewhat different radioactovities (eU = 1.64, 2.04 and 1.46 ppm. respectively). In extensive potassic attacks part of the introduced radioelements may again be carried away.

Unlike the basic intrusions, *in the acidic intrusions* of the studied samples, the degree of alteration does not always give a ready clue to the relative radioactivity of the rocks. The fifth most radioactive dyke from Qoseir (No. 45, with eU = 19.10 ppm.) is a fresh bostonite almost without pyriboles; while the two most radioactive dykes (Nos. 50 and 48, with eU = 24.45 and 24.24 ppm. repectively) are partly altered solvsbergites with albitic feldspar lightly stained by hematite and all pyriboles are oxidized to hematite pseudomorphs. The second most radioactive equivalent bostonite intrusion in the Aswan district (No. 7, with eU = 13.05 ppm., pl. III, A) displays strong alteration even though the much altered and almost opaque feldspar leths had a late clear mantle. Many other similar examples were noticed and these variations seem to be best explained by the manner of the actual distribution of the radioelements which in turn depends on several factors (see No. 3 below). However, generally speaking and with certain exceptions, the more altered acidic rocks of the sampled collection are less radioactive. Thus in the acidic intrusions where composite samples were collected separately from the less and more altered parts (e.g. samples 5 and 6, pl. I, A samples 46 and 47, pl. I, B samples 15 and 16, and samples 28 and 49), the less altered parts or fresh cores were always more radioactive than the altered parts, sometimes by a factor of 2. The penetrating hydrothermal solutions and vapour while introducing some of the iron oxides and causing other alterations, had presumably leached away part of the radioelements. The presence of much xenocrysts and inclusions of the hostrocks in parts of the dyke intrusions may also alter

the radioactivity and introduce new complicating factors (e.g. samples 17 and 18, pl. III, B.

That such streaming vapours and hydrothermal solutions had a strong oxidizing influence is evidenced by the ready destruction of most of the alkali amphiboles, by their replacement by iron oxide pseudomorphs, by the strong introduction of finer hematite dust and granules in intergranular and interstitial spaces, and by the hematite staining of the feldspar laths in the majority of the acidic dykes of Aswan and Qoseir. Under such conditions, any pre-existing « primary » quadrivalent uranium in these intrusions or in the host-rocks can be readily oxidized into the highly mobile hexavalent state, the uranyl ion, which easily dissolves in a variety of solutions both acid and basic. Hence, the strong variation and wide scatter of radioactivity in the hydrothermally affected acid intrusions is to some important extent, probably due to large differences in content of the mobile uranium in these intrusions rather than to large differences in their thorium content.

The relatively low radioactivity of the fluidized dykes and granophyres (samples 1, 2, and 3, pl. II, A-B) may also be explained by the leaching away of much of the radioelements in the strong uprushing stream of hot gases and volatiles to which the gasified particles and fragments of the pre-existing fluidized rocks had been subjected.

When the waning stages of volcanicity had been reached, e.g. when the late hydrothermal solutions had cooled down into the solidified rocks, or when the magma had solidified in the presence of much hyperfusibles, rocks of high radioactivity would be produced if there was an appreciable hexavalent uranium etc. previously carried in such solutions (for conditions of deposition of the transported uranium, see McKelvey et al., 1956, p. 552-553, who also state that ferrous iron in rocks might also act as a reducing and hence precipitating agent for the uranyl ion. See also Roubault and Coppens, 1958, p. 336).

3. *Distribution and localization of radioactivity :*

It is well known (e.g. Larsen and Phair, 1954, p. 88-89) that in view of their large ionic radius and charge, quadrivalent uranium and thorium ions become concentrated in late residual magmatic fractions

and in accessory minerals, but in the very late magmatic stages, uranium can be oxidized to the hexavalent state, e.g. by relief of pressure caused by intrusion of magma into higher levels. This will cause the hexavalent uranium to leave the thorium and crystallize with the final hydrothermal silica-rich solutions. Neuerburg (1956, p. 233) had listed six modes of occurrence of uranium in the fabric of igneous rocks : (1) in uranium minerals, (2) substituting in minor amounts for cations in the structure of rock minerals or occupying structural defects in such minerals, (3) uranium held in cation-exchange positions, (4) uranium adsorbed on crystal surfaces, on surfaces of crystallographic discontinuities, and on surfaces of irregular cracks within crystals, (5) uranium dissolved in fluid inclusions inside the rock minerals, and (6) uranium dissolved in intergranular fluids. The more loosely held uranium in a rock could precipitate from soluble mobile uranium during any late deuteric and hydrothermal stages, metamorphic episodes, or during weathering. Because it is generally emplaced along passageways for the various solutions that may have passed through the rock, and as it is loosely held, this labile uranium is also easily leachable by acids and its amount is subject to change from time to time. Some metamict minerals and others like apatite are also leachable under certain conditions. Neuerburg (1956, p. 236-237) states that because uranium in each of its different occurrences shows variable accessibility and reactivity to solutions which may affect the rock, it may be possible to isolate or determine separately the amount of uranium in each fabric occurrence. The total uranium content of an igneous rock represents the interaction of a complex series of events taking place during and since its crystallization. These total uranium contents are dynamic quantities that cannot be referred to any single event and are probably changing from day to day by some infinitesimal amount. The uranium content of an igneous rock is thus a highly uncertain or indecipherable measure of the uranium content of its magma since ample opportunity existed and still exists for repeated changes, not only of the total uranium content but also of the proportional distribution of uranium among each of its different modes of occurrence (see an example given recently from the Vendée granites by Roubault and Coppens, 1958).

Hurley's (1950) important work on granulated igneous rocks was the first to show clearly that as much as 90 per cent of the radioactivity of an igneous rock can occur along interstitial spaces and coatings, along fractures and on grain surfaces, and is readily leachable by 1 : 5 hot HCl. Later studies showed that this leachable radioactivity varies widely in rocks, and Larsen and Phair (1954, p. 81) state that it is in vogue at present to interpret leachable material as perhaps representing a sample of the last material to solidify in the igneous rock (or to be deposited from late solutions of any origin) being finally deposited as weakly attached films on surfaces of pre-existing minerals, in interstitial grain boundaries or in newly formed fractures.

The best methods to study the localization of radioelements in igneous rocks is by autoradiographic techniques (especially with gel emulsions melted and poured on uncovered thin sections of rocks) and, perhaps by carefully conducted leaching tests. Experiments along these lines are now being carried out on the relatively more radioactive samples of the minor intrusions of Aswan and Qoseir and will be reported at a later date. Preliminary leaching tests with hot 1 : 5 HCl on three powdered (not granulated) samples, originally used for determining the specific activities gave the following results, activities are $\times 10^{-6}$:

Sample Number	Alpha Activity	Activity of leached sample	Percentage of leachable radioactivity
—	—	—	—
7	1277	1226.0	4.0 %
45	1726	840.0	51.4 %
48	2180	717.2	67.1 %

The least leachable radioactivity of these three samples is that of the regenerated Aswan bostonite No. 7 for although the intrusion is rich in hematite granules and dust, these are all enclosed within the fresh generation of feldspar. The two other radioactive bostonites from Qoseir lose as much as 50 % or more of their radioactivity after the acid leaching. In the first Qoseir sample much iron is leached as well, denoting perhaps late stage introduction and adsorption of the uranium in the iron oxides. Neuerburg (1956, p. 237) quoted Phair in stating that labile uranium,

represented largely by sexivalent uranium minerals, in two bostonites contributed a substantial part of their anomalously high uranium content. Roubault and Coppens (1958, p. 335) found that in some altered Vendée granites, the ferruginous alterations in chloritized biotite, in fissures filled with iron oxide, and in some strongly reddened feldspars to be very radioactive. Tiny fluid pores and vacuoles so common in the turbid and hematite-stained feldspar laths of the acidic Aswan and Qoseir intrusions may have contributed significantly to the total radioactivity of these rocks. In the fresh bostonite sample No. 45, radioactivity is relatively high but no hematite alterations occur. On the contrary, its radioactivity is reduced when this happens (samples 46 and 47). Pyriboles are almost absent. Its high radioactivity seems to be due to fluid pores and vacuoles in and between the feldspar laths and to the presence of frequent tiny yellowish high relief granules of an unidentified mineral (beside the zircon granules whose radioactivity is not much affected by the acid leaching tests).

Although some of the present Aswan (and Qoseir) minor intrusions are rich in apatite (whose ingredients had been probably supplied from depth by juvenile solutions, or which had initially crystallized primarily), and although apatite is sometimes reported in the literature to be radioactive with uranium substituting for some of the calcium, no appreciable correlation between the apatite content and the radioactivity of the sampled collection was noticed either in the acid or basic intrusions of both areas, unless apatite is of different composition in the different intrusions which is unlikely. Some highly radioactive intrusions are extremely poor in apatite (e.g. sample 45 of fresh bostonite). In the basic intrusions, contacts between apatite inclusions and enclosing biotite or amphibole do not show any dark halos round them. Some dolerite and dioritic minor intrusions are rich in accessory apatite and yet these rocks are not significantly radioactive (e.g. No. 20, pl. IV, A). The fact that an appreciable increase in the radioactivity of these rocks sets in when the outer peripheral borders of their pyroxenes and serpentine pseudomorphs alter to sodic amphiboles (in camptonites) or when hornblende and magnetite alter peripherally to biotite (in some diorites and kersantites) indicate that the bulk of the radioelements in these rocks was introduced later in the deuteric or hydrothermal drafts and along intergranular boundaries (pl. VII, B).

As stated earlier, the decrease of radioactivity in the fluidized intrusions or in some highly iron-oxide stained intrusions may be due to the leaching of pre-existing interstitial and loosely held radioactive ingredients, depending upon the composition of the fluidizing or circulating agent, its temperature and other physico-chemical conditions prevailing at the different levels and in individual intrusions. In certain volcanic diatremes, Shoemaker (1956) had shown that there was an increase in radioactivity.

4. *Relation between radioactivity and manner of intrusion :*

Larsen and Phair (1954, p. 80) remarked that preliminary evidence from several sources suggests that volcanic and hypabyssal rocks may average somewhat higher radioactivity and uranium content than do plutonic rocks of similar composition. Thus (apart from certain rare alkalic granites), bostonites, quartz-bostonites and some lamprophyre dykes are known to be among the most radioactive igneous rocks of the world, e.g. the quartz-bostonite porphyries of the Colorado Front Ranges (Central City District) have an average eU content of 120 ppm., most of which is, however, labile.

Reference to Tables I and II will show that the radioactivity of the average *fresh* bostonitic and acid-alkaline dykes is much higher than that of the average granites and granodiorites, the chief host-rocks in the Aswan and Qoseir districts. Indeed the radioelements may have been largely derived and concentrated from the host-rocks into some of the younger minor intrusions by more than one mechanism at deeper levels.

5. *Relation between radioactivity and order of intrusion :*

Larsen and Phair (1954, p. 86) also observed that in a series of *genetically related* intrusions, the youngest intrusions are generally the most radioactive. In the Aswan and Qoseir districts, it is true that the fresh acid bostonite-solvsbergite suite and the basic alkaline suite of dykes are on the whole more radioactive and seem to be younger than the basic dioritic and doleritic lamprophyre dykes or of their host rocks.

However, a straightforward order of intrusion between these minor intrusions cannot be satisfactorily worked out. This is partly due to (1) the rarity of exposures of such dyke intrusions crossing others, (2) the contrasting different mechanisms by which these different dykes probably evolved (by differentiation, assimilation, fluidization, fluxing and melting, late hydrothermal alterations etc.), and (3) the erratic emplacement and variation in composition of intrusions and extrusions common in many volcanic provinces. Two different dykes may be emplaced more or less simultaneously. In Aswan, the radioactive bostonitic dyke (No. 7) cuts three dioritic lamprophyre less active intrusions (Nos. 24, 26 and 28) and is consequently younger than them. On Biga Island, a basic camptonitic dyke (No. 43), with pre-existing olivine, cuts a kersantite dyke (sample No. 37) and the younger dyke is also slightly more radioactive than the older one. Mention has already been made of the variation in composition and radioactivity along probably the same dyke intrusion (e.g. samples 41 and 42 ; 29, 35, and 25).

If it is feasible to compare the Old and New Aswan granites with the later bostonitic suite, we find that radioactivity increases progressively from eU ppm. of 7.58 (average content of Old Aswan granite) to 11.29 (average content of 13 New Aswan Granites) to still higher values *in the fresh and least altered* bostonitic intrusions (e.g. Nos. 5 and 7). The same occurs in Qoseir.

6. *Relation between radioactivity and petrographic provinces :*

The coarse Aswan granite contains metamict brown grains of allanite and yellow allanite crystals up to 2 mm. long as well as zircon and sphene but allanite is the chief contributor to the radioactivity of this granite (allanite with specific radioactivity of 0.4 to 0.2 alphas/cm.^{2}/sec.). The average radioactivity of the Qoseir granodioritic intrusions (the most frequent type of granitic intrusions there) is roughly twice that of the average Aswan coarse granite (the most predominant granite there). They have average eU content of 12.7 and 7.6 ppm. respectively. The Qoseir true granites are even/more radioactive than their Aswan counterpart with eU content of from 13 to 20 ppm. This difference in radioactivity can even be readily indicated by simply observing the frequency and

intensity of pleochroic dark halos in the biotite and amphibole in thin sections of these granites and granodiorites (Gindy, 1956, p. 106 ; 1958, p. 573). Although the radioactivity of plutonic rocks depends on several other factors such as depth and erosional level (Ingham and Keevil, 1951, p. 135, 137) and on degree of weathering (Smith and Flanagan, 1956), it is interesting to note that the minor fresh intrusions of the Aswan district are similarly less radioactive than their corresponding equivalents from Qoseir (see tables I and II). In the studied collection, the most radioactive bostonitic dyke from Aswan has eU = 15.40 ppm. while the Qoseir counterpart has 24.45 ppm. This is quite apparent in the frequency curves of the radioactivity of minor intrusions in both regions (fig. 4). Frequency curves for the Aswan bostonites are, however, somewhat more peaked (with higher kurtosis values) than the corresponding Qoseir curves, but several interfering factors such as degree of weathering and gaseous and hydrothermal attacks etc. may be responsible for this higher kurtosis. Detailed study of the distribution of radioactivity in the different host rocks of both Aswan and Qoseir districts will be dealt with separately.

7. *Relation between radioactivity and depth :*

It is difficult to assess this relation on the minor intrusions of Aswan and Qoseir since no subsurface samples from deep quarrying operations or borings are available and in view of the erratic activities of fluxes and volatiles intrinsic to these intrusions.

VI. — SUMMARY AND CONCLUSIONS

1. The results of determination of the alpha radioactivity of 72 samples from the late minor dyke and neck intrusions of the Aswan and Qoseir districts, using photographic nuclear emulsions, are given in Tables I and II.

2. In both districts, acid minor intrusions are more variable in their radioactivities but on the whole they are much more radioactive than basic ones (see figs. 1 and 2).

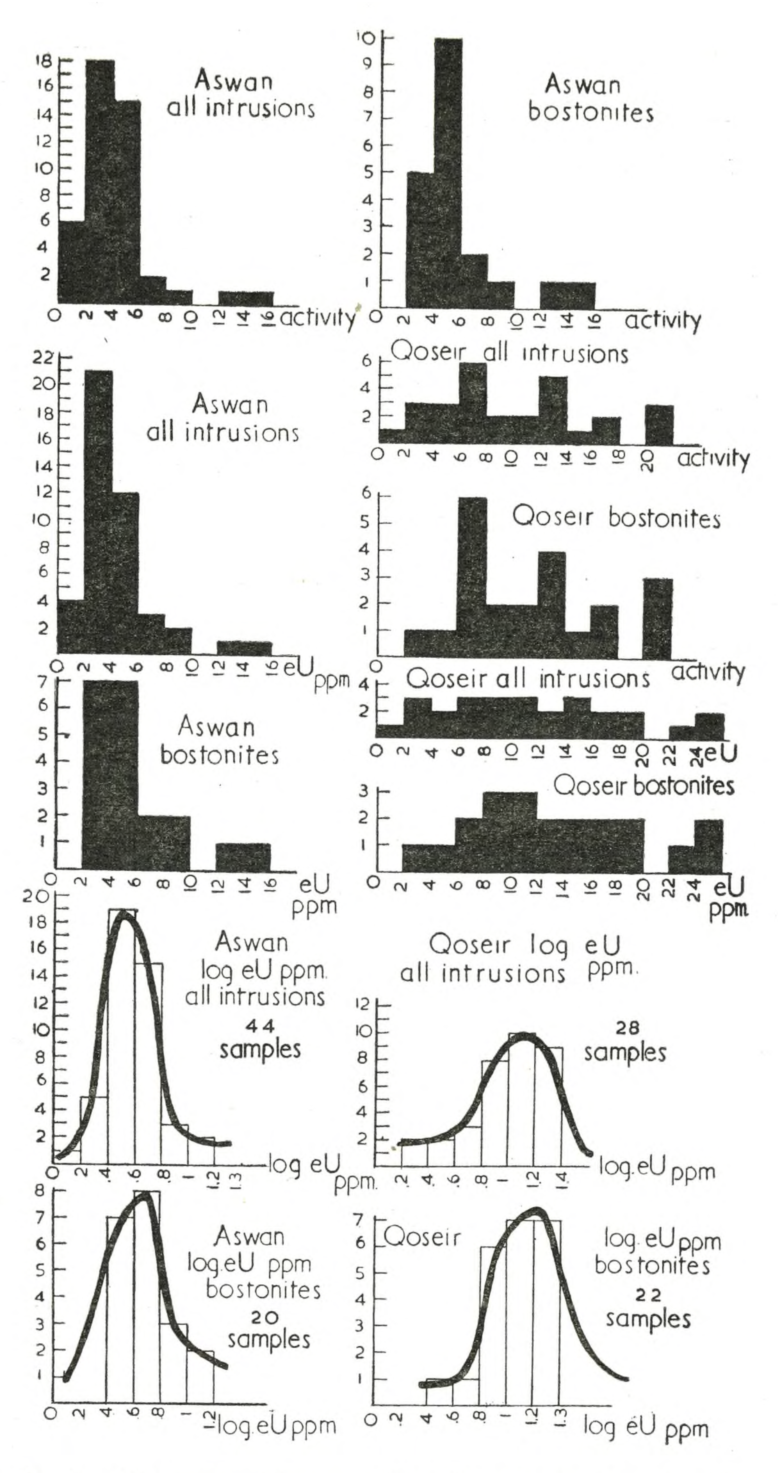


FIG. 4. — Histograms and frequency distribution curves for the radioactivity in alphas 10^{-4}/cm. 2/sec., eU ppm. and log. eU ppm. contents of the different studied samples of minor intrusions. Co-ordinates in all cases refer to number of samples. Here, under bostonites are included the granophyres.

3. Among the basic minor intrusions, alkaline, particularly sodic, varieties are more radioactive than equivalent non-alkaline varieties.

4. On the whole, alteration and weathering reduce the radioactivity of the more radioactive intrusions (particularly the bostonites), probably by leaching away part of their labile uranium.

5. The acidic late minor intrusions of Qoseir are more radioactive than their equivalents in Aswan; a discovery that is also reflected in the radioactivities of their major granitic host-rocks. The Qoseir petrographic (somewhat near-volcanic) province is thus characterized by relatively higher radioactivity than that of Aswan.

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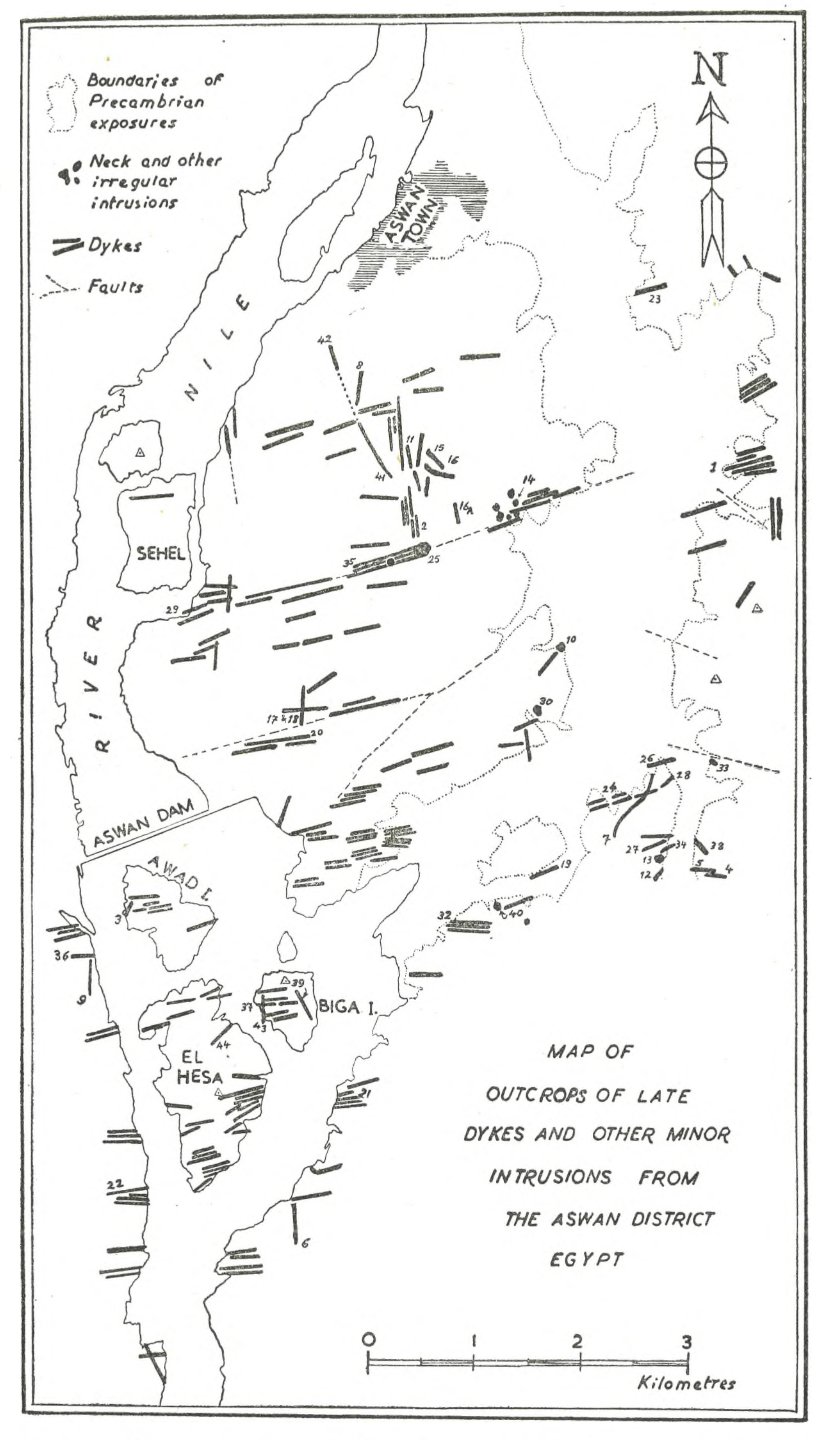
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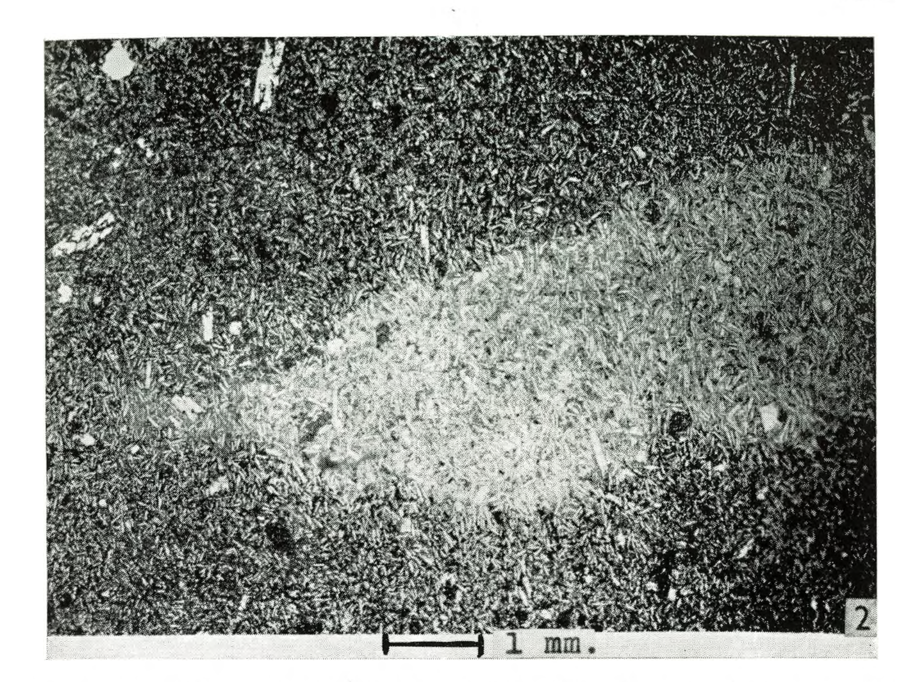
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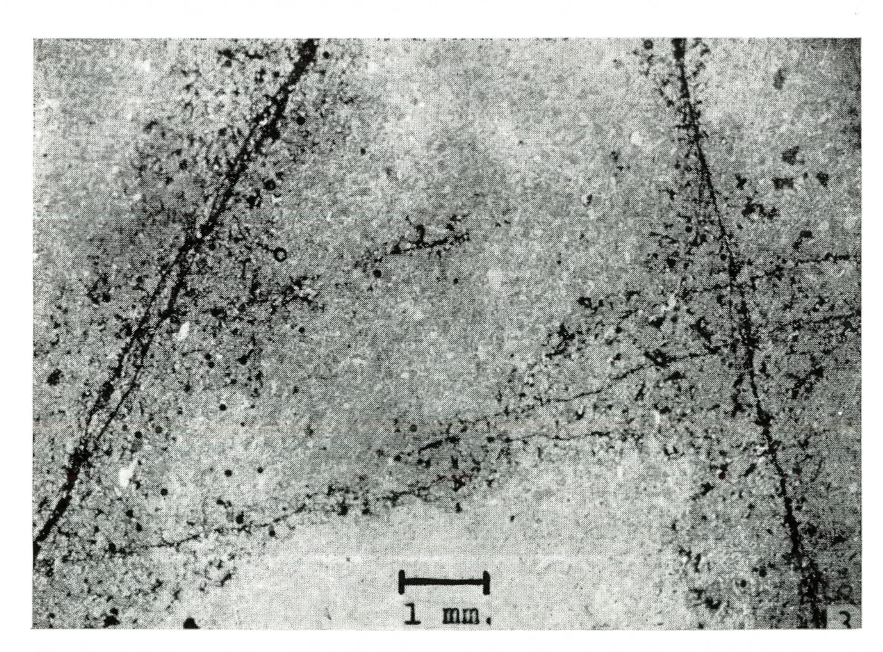
MAP. 1



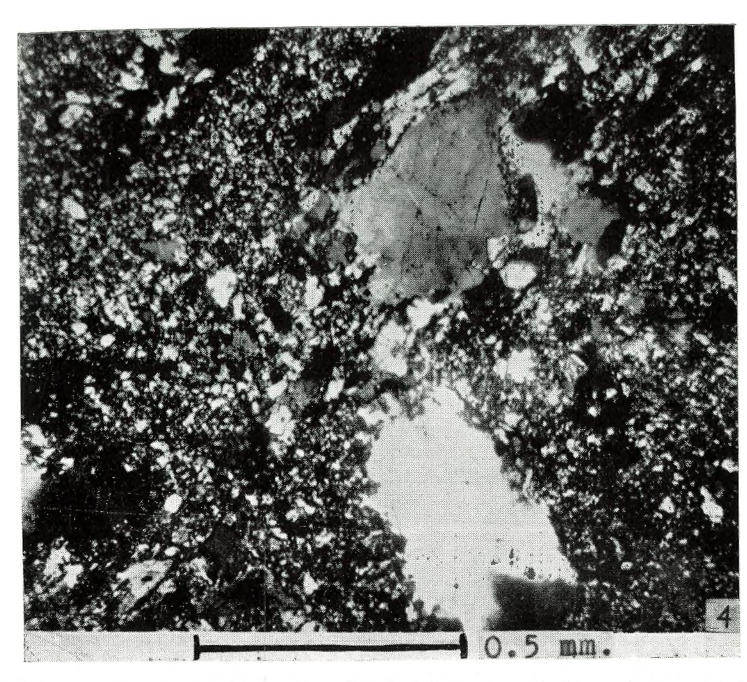
MAP 1. — Map showing the distribution of late Pre-Cambrian minor intrusions in the Aswan district. Lengths and widths are exaggerated. From the original 1: 10.000 exposure map (Gindy, 1956). Sampled intrusions are given numbers corresponding to their samples in Table I.



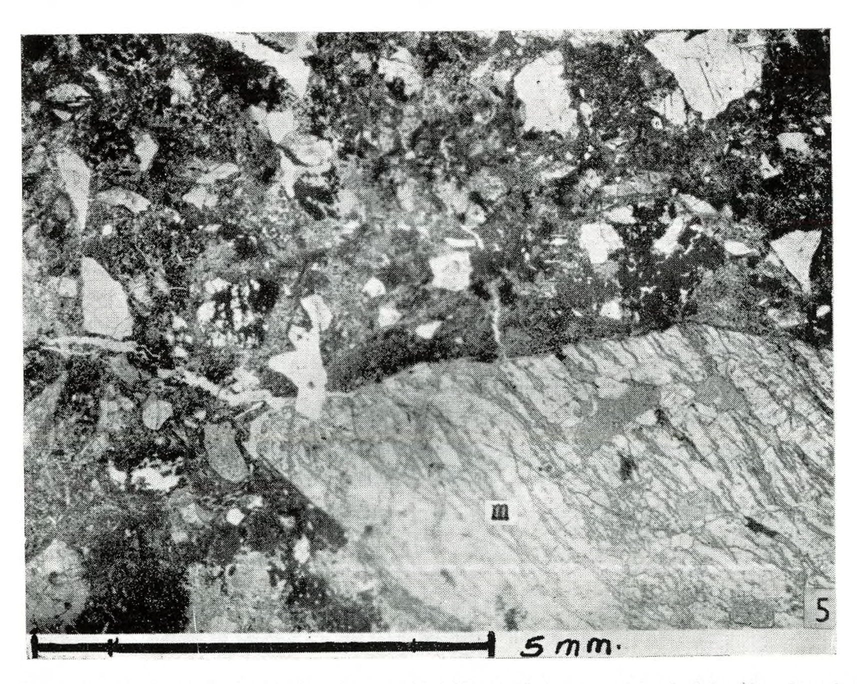
A.—Photomicrograph of a bostonitic dyke (No. 4) from Aswan showing hydrothermally altered ferruginous parts with a relict non-ferruginous fresh core. The fresh core is nearly twice as radioactive as the altered parts and is identical to the most radioactive dyke in Aswan (Sample 5). $\times 11\frac{1}{2}$, O.L.



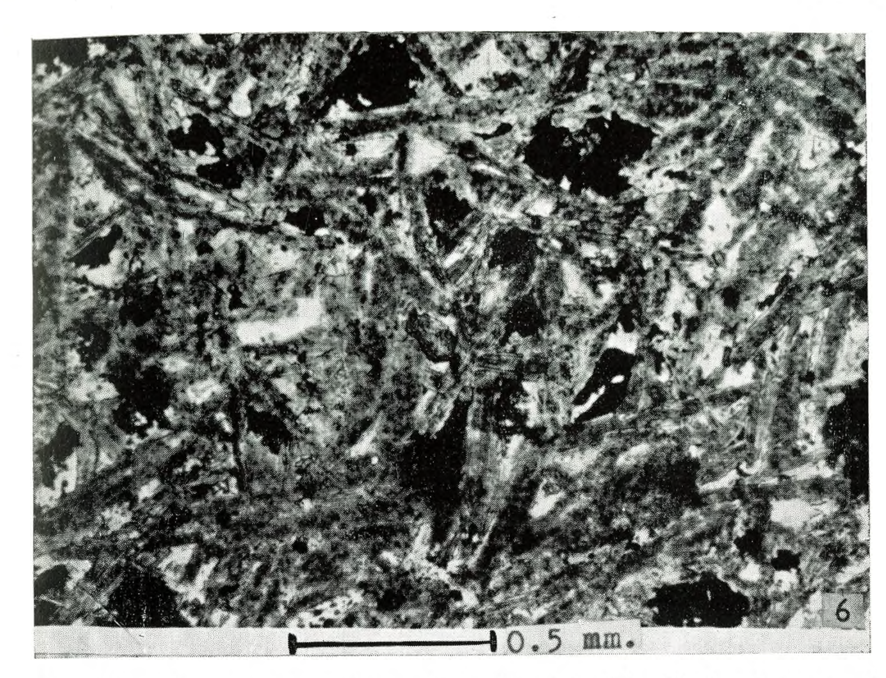
B.—Photomicrograph of a bostonite dyke (No. 46) from Qoseir showing incipient alteration and ferruginous depositions along joint and minor fractured planes with consequent reduction of radioactivity caused by the leaching away of part of the radioelements. $\times 11\frac{1}{2}$, O.L.



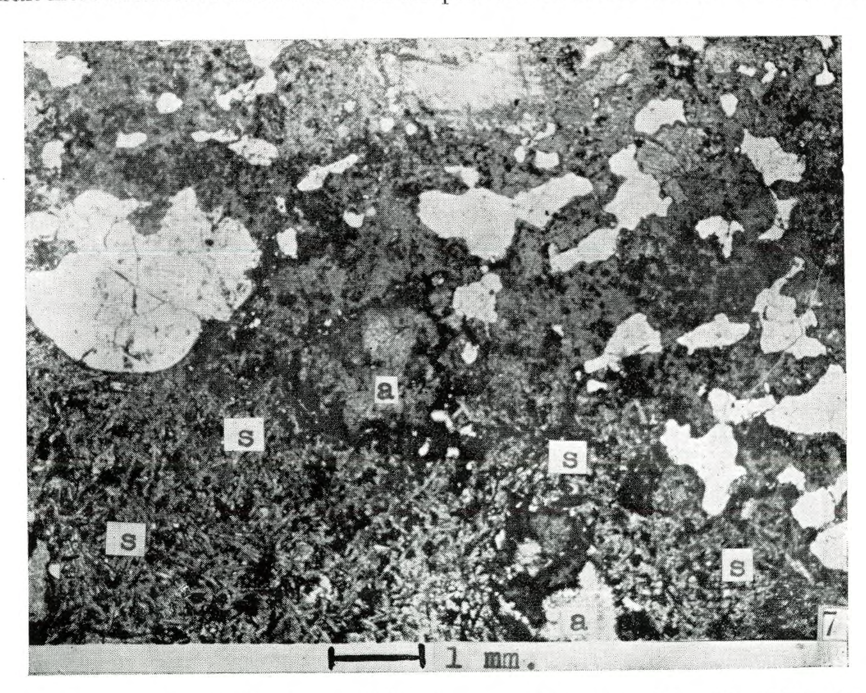
A.—Photomicrograph of a granophyre dyke (No. 2) from Aswan, actually a gasified granulated granite with large xenocrysts of quartz with trains of fluid pores in a finely granulated matrix. $\times 70$, Crossed nicols.



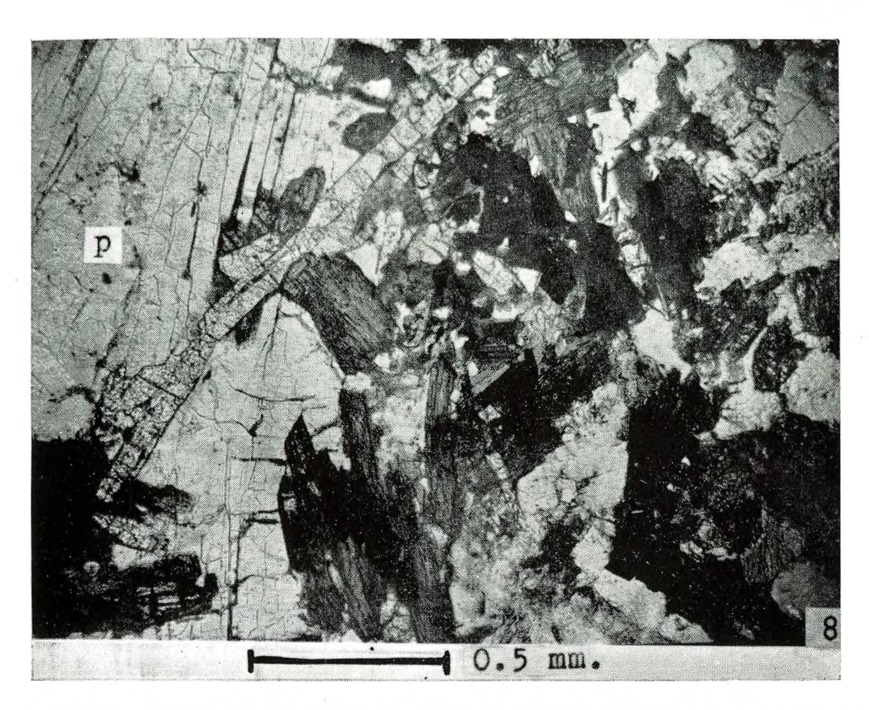
B.—Photomicrograph of the Aswan fluidized dyke on Awad Island, showing relics of granite fragments : microcline-microperthite (m), quartz and plagioclase in a devitrified originally glassy matrix, in parts rich in iron-oxide granules. $\times 12$, O.L.



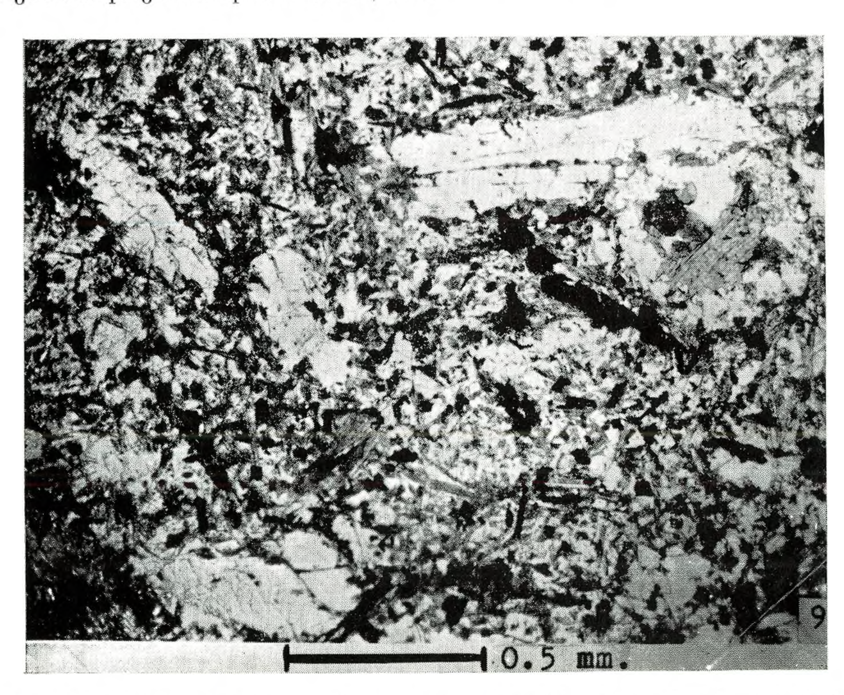
A.—Photomicrograph of an Aswan bostonitic dyke (No. 7) showing strongly altered and hematite-stained albite laths and opaque iron-oxide pseudomorphs of pre-existing pyribole. Notice the development of fresh outer rims to the albite laths. Tiny fresh late biotite flakes do not show well in figure. This is the next most radioactive intrusion in the sampled collection from Aswan. × 51, O.L.



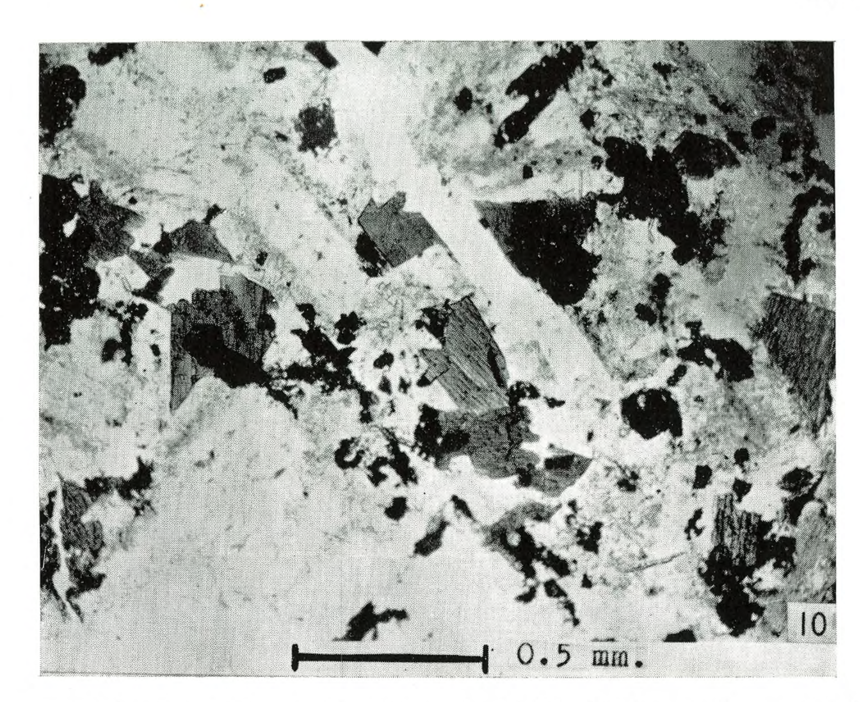
B.—Photomicrograph of a xenolithic Aswan solvsbergite dyke (No. 17). The large granite xenolith occupies more than half the figure (above the diagonal from the upper left corner to the lower right corner of the figure). In it the feldspars of the granite peculiarly embay, as if replacing, the original quartz. (s) refers to the « normal » solvsbergite; (a) to an amygdule in it. × 11 ½, O.L.



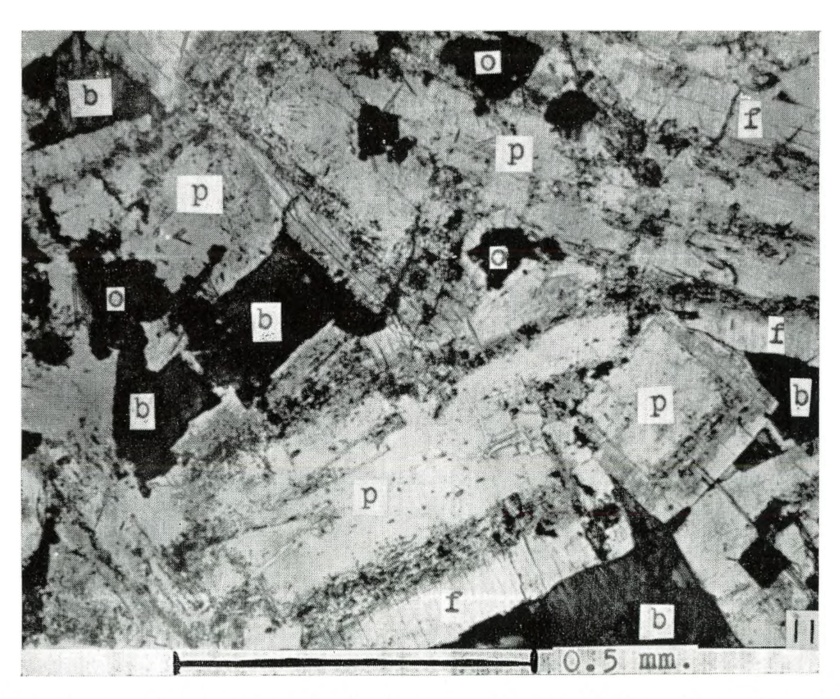
A.—Photomicrograph of an Aswan dolerite dyke (No. 20). In the area shown, much biotite, amphibole and chlorite replace the pre-existing pyroxene. Notice the long large fractured apatite crystal, in part with a dark core. (p) refers to a large basic plagioclase plate. × 51, O.L.



B.—Photomicrograph of an Aswan kersantite (No. 35) showing extensive development of biotite, some porphyritic crystals of andesine and opaque granules. × 52, O.L.



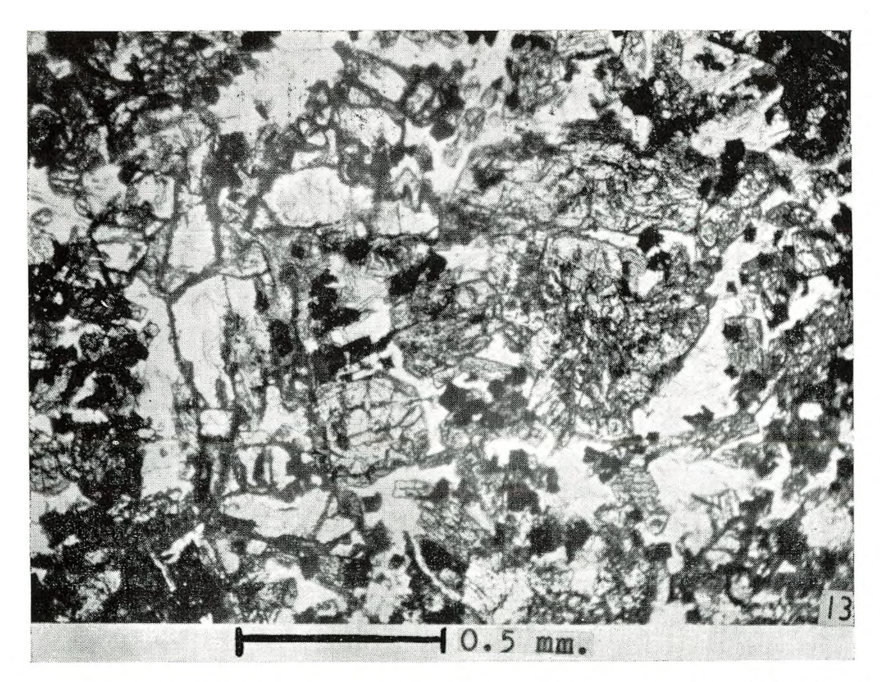
A.—Photomicrograph of an Aswan barkevikite-bearing acid camptonite (No. 28). × 51, O.L.



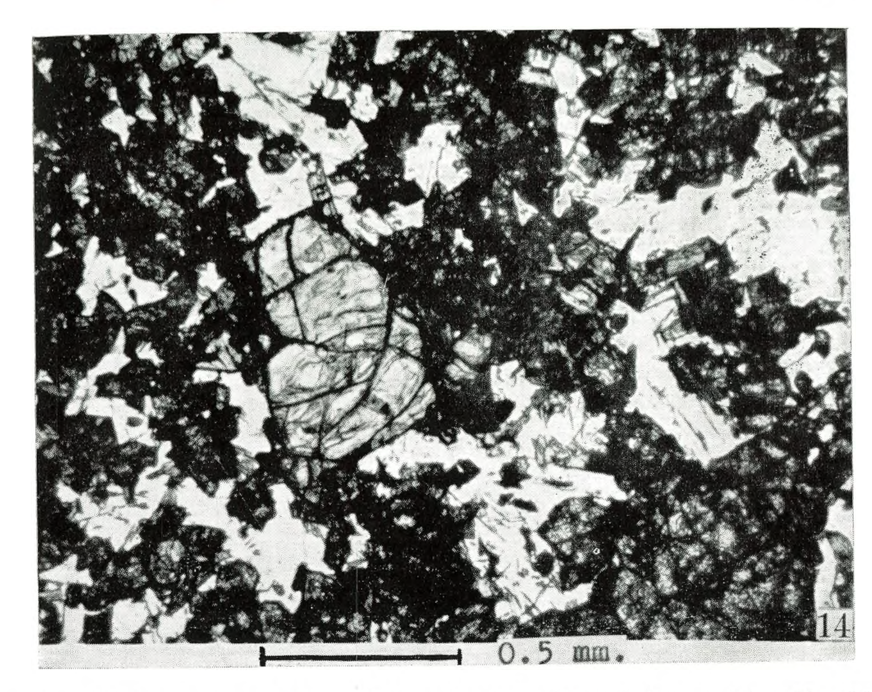
B.—Same as fig. A but under higher magnification to show barkevikite (b), oligoclase plagioclase (p) with an altered border surrounded from outside by clear potash feldspar (f). (o) refers to opaque granules. × 97, O.L.



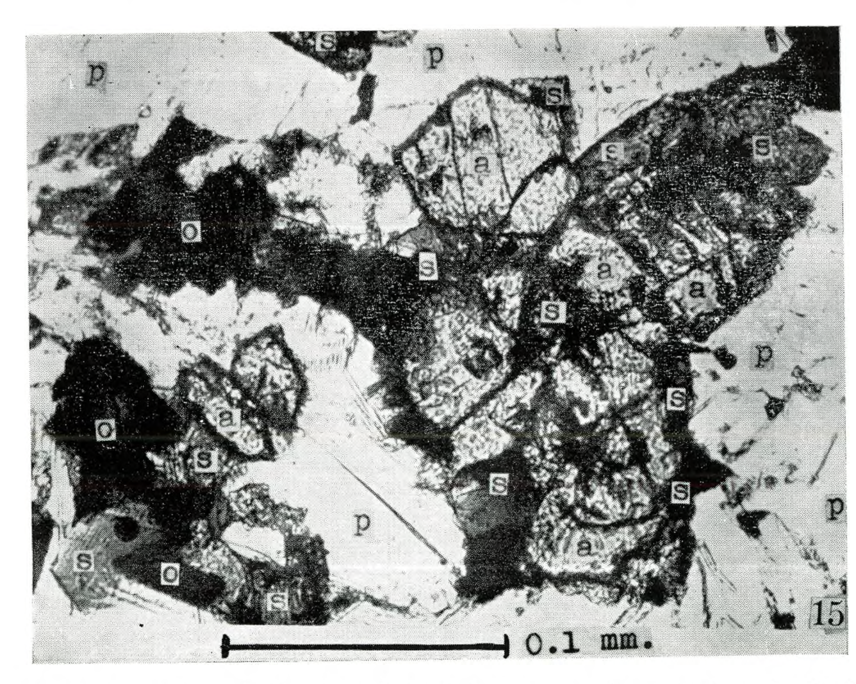
A.—Photomicrograph of a basic Aswan camptonite dyke (No. 42) showing a barkevikitic red brown amphibole prisms and cross sections, andesine, opaques and several tiny apatite needles. × 52, O.L.



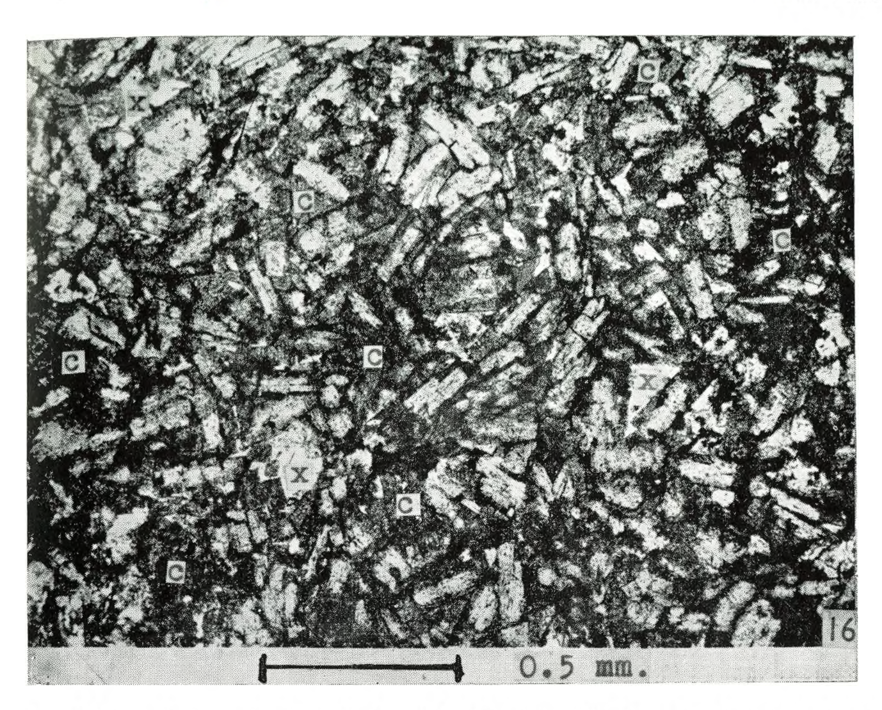
B.—Photomicrograph of an originally olivine-dolerite dyke (No. 43) with all pyroxene grains partly replaced by a soda amphibole, Aswan. × 51, O.L. (See also fig. B, Plate VII).



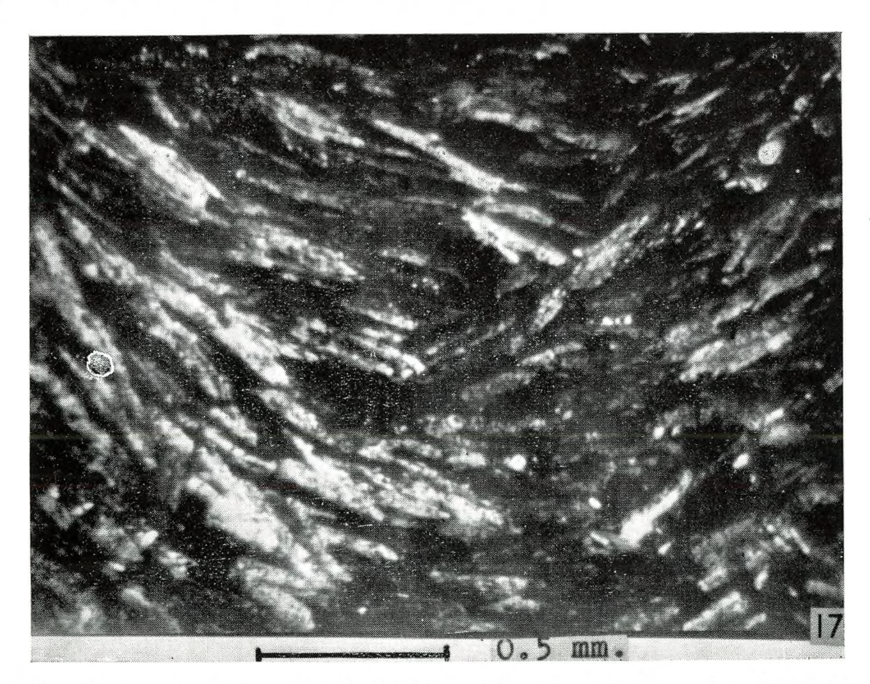
A.—Similar to fig. B, Plate VI but from a different Aswan dyke (No. 44) and showing more clearly one serpentine pseudomorph after olivine. For clearer detail of the darker minerals in figure see fig. B. × 51, O.L.



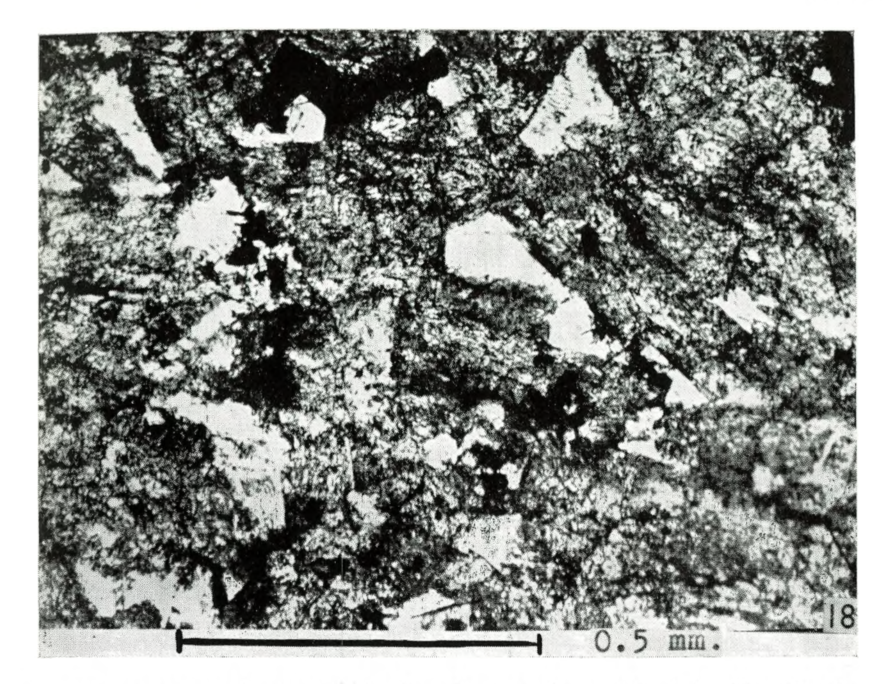
B.—Photomicrograph of a part of the darker areas of fig. A to show clearly the peripheral replacement of augite crystals (a) by a barkevikitic red brown soda-amphibole (s). (o) refers to opaque granules and (p) for andesine. × 190, O.L.



A.—Photomicrograph of a solvsbergitic dyke (No. 60) from the Qoseir district, showing hematite-stained albitic laths, intergranular quartz (x), chloritized pyriboles (c) and opaque granules. × 52, O.L.



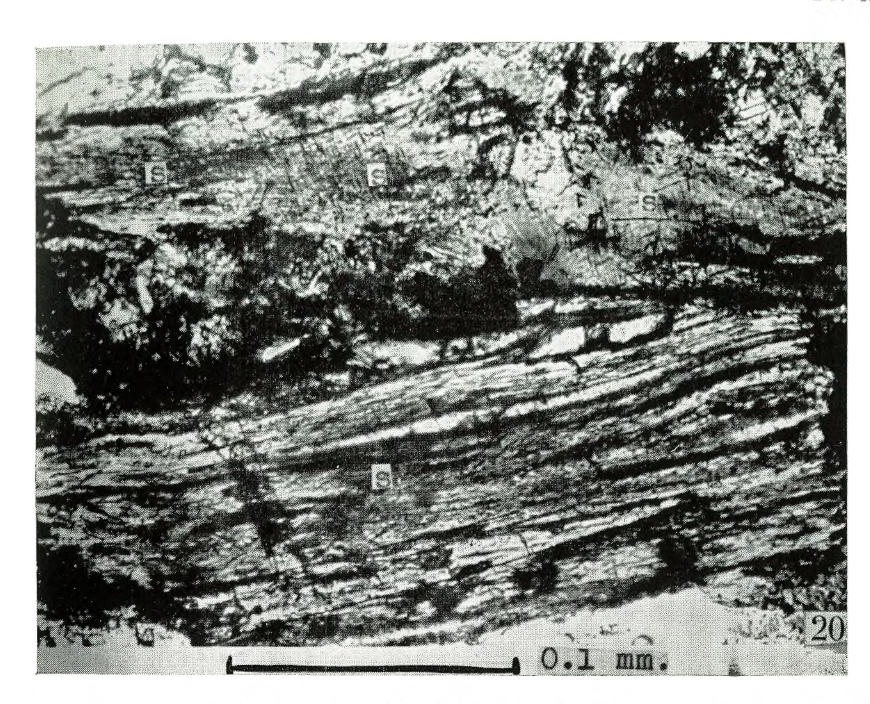
B.—Photomicrograph of a solvsbergitic dyke (No. 53) from Qoseir, showing fluxional flow fabric. × 51, Crossed nicols.



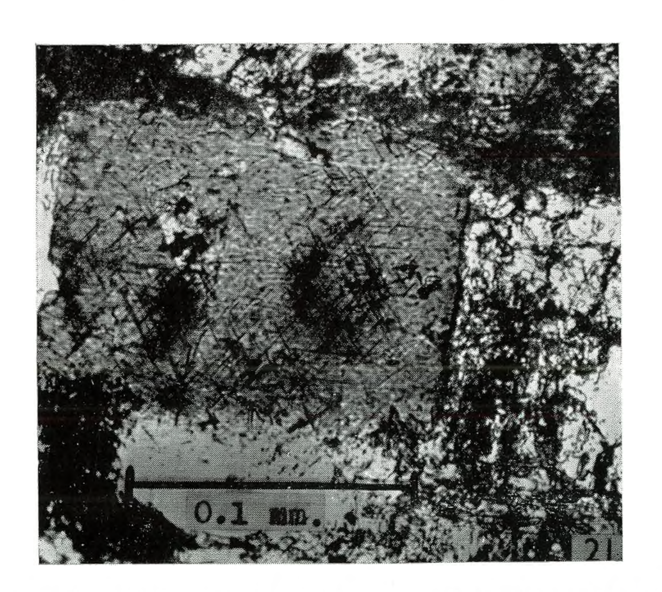
A.—Photomicrograph of a much altered quartz-bostonitic dyke (No. 61) from Qoseir : white areas of quartz, grey areas of strongly hematite-stained albitic laths, black grains of opaques. × 97, O.L.



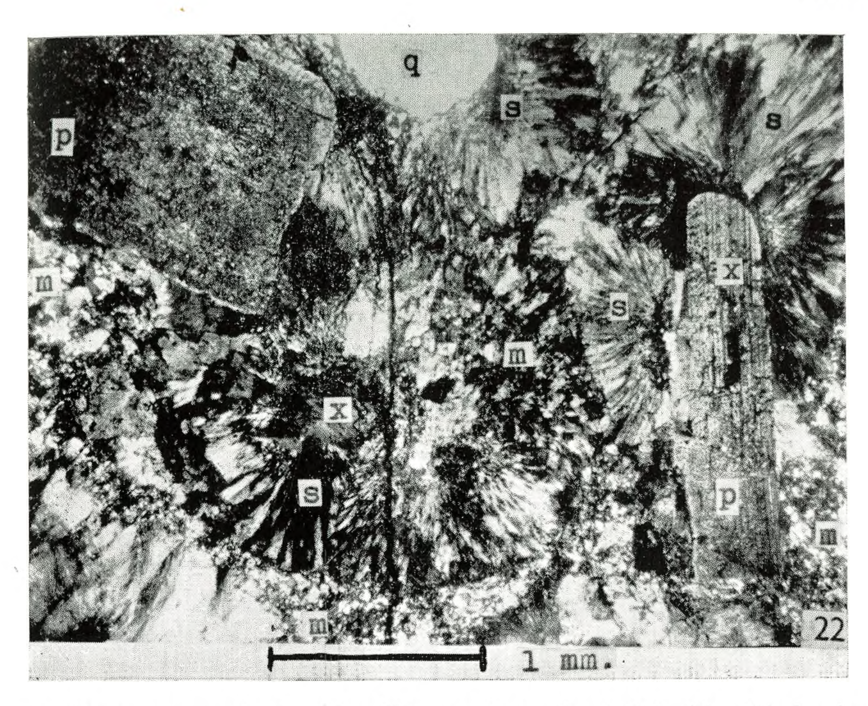
B.—Photomicrograph of a leached minette-kersantite dyke (No. 67) from Qoseir district. Notice the deformed and folded (f) biotite flakes. Release of tiny opaque rods in metamict areas of the biotite flakes are seen better in figures A and B Plate X, from the same thin section. × 51, O.L.



A.—Photomicrograph from the dyke of fig. B, Plate IX, showing two biotite flakes interleaved by prehnite (with bands) and release of opaque rods, often in net-like sagenitic arrangement (s) around metamict areas of biotite forming the dark halos around former radioactive nuclei. × 190, O.L.



B.—Another photomicrograph of an almost basal flake of biotite from the dyke of fig. B, Plate IX and A, Plate X, showing the reticulate tiny dark rods released around previously metamictized dark halos of the biotite enclosing formerly radioactive nuclei. × 190, O.L.



A.—Photomicrograph of a spherulitic porphyrite Qoseir Dyke (No. 63) showing porphyritic oligoclase crystals (p) and resorbed porphyritic quartz (q), with much spherulites (s) in a granophyric-felsitic matrix (m). Some of the spherulites develop around the porphyritic crystals or around part of them as at (x). × 27, Crossed nicols.



B.—Photomicrograph from the same dyke of fig. A but showing highly embayed and resorbed relics of porphyritic quartz (q), sometimes (as at x) acting as nuclei for the spherulites. × 13, Crossed nicols.

EXPLICIT SOLUTION OF DYSON'S EQUATIONS IN QUANTUM ELECTRODYNAMICS [1]

BY

A. SABRY

Many attempts have been made for an explicit solution of Dyson's integral (2). Feynman (3) has shown that the possible terms in any n^{th} order integral can be represented and easily remembered by graphs. Each graph is composed of n points connected by different photon and electron lines.

This method is however not very practical, especially for higher n's when it becomes very complicated.

Caianiello (4) has succeeded in expressing all the contributions in the integrand of an nth integral as a determinant in the electron-position functions multiplied by a « hafnian » in the photon functions.

A simpler and more clear method of approach for the explicit solution will be suggested in this paper, and by a proper choice of position wave functions and operators, no complications of over-all sign will appear.

We start from Dyson's equation :

$$S = \sum_{n=0} S_n$$

$$S_n = \left(\frac{-i}{\hbar}\right)^n \frac{1}{n!} \int dx_1 \dots \int dx_n \; P\left(H(x_1) \dots H(x_n)\right) \qquad (1)$$

where P is the known chronological order symbol.

The probability amplitude from an initial *to* a final state described by the state vectors Ψ_i, Ψ_f respectively is given by the matrix element.

$$P_{if} = (\Psi_f, S\,\Psi_i) \qquad (2)$$

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[1] Communication lue en séance du 21 mai 1959.

We assume now that initially we have a n electrons, m positions, r photons and finally n' electrons, m' positions and r' photons. — The state vectors Ψ_i, Ψ_f initially and finally will then be given by :

$$\Psi_i = b^*_{p_1 \alpha_1} \dots b^*_{p_n \alpha_n} . b_{q_1 \beta_1} \dots b_{q_m \beta_m} . \tilde{a}_{k_1 \mu_1} \dots \tilde{a}_{k_r \mu_r} \Psi_o \qquad (3)$$

$$\Psi_f = b^*_{p'_1 \alpha'_1} \dots b^*_{p'_{n'} \alpha'_{n'}} . b_{q'_1 \beta'_1} \dots b_{q'_{m'} \beta'_{m'}} . \tilde{a}_{k'_1 \mu'_1} \dots \tilde{a}_{k'_{r'} \mu'_{r'}} \Psi_o \qquad (4)$$

where $b_{p\alpha}$, $b_{q\beta}$ are operators appearing in the expansion of the Dirac field operator $\Psi(x)$.

$$\Psi(x) = \frac{1}{(2\pi)^{3/2}} \int d^3 p \left\{ \sum_{\alpha=1}^{2} b_{p\alpha} u^{\alpha}(p) e^{ipx} + \sum_{\beta} b_{p\beta} u^{\beta}(p) e^{ipx} \right\} \qquad (5)$$

The first sum is over electron states $p_o = \hbar\omega$ and the second over position states ($p_o = -\hbar\omega$).

On the other hand, the operators $a_{k\mu}$ appear in the expansion of the electromagnetic field operator $A_\mu(x)$

$$A_\mu(x) = \sqrt{\frac{\hbar c}{16\pi 3}} \int \frac{d^3 k}{|k|^{1/2}} \left(a_{k\mu} e^{ikx} + \tilde{a}_{k\mu} e^{ikx} \right) \qquad (6)$$

and $a_{k\mu}$, $b_{p\alpha}$, ... satisfy

$$[a_{k\mu}, a_{k'\mu'}] = [\tilde{a}_{k\mu}, \tilde{a}_{k'\mu'}] = o, \; [a_{k\mu}, \tilde{a}_{k'\mu'}] = \delta_{\mu\mu'} \delta^3(\bar{k}-\bar{k}') \qquad (7)$$

$$[b_{p\alpha}, b_{p'\alpha'}]_+ = [b^*_{p\alpha}, b^*_{p'\alpha'}]_+ = o, \; [b_{p\alpha}, b^*_{p'\alpha'}]_+ = \delta_{\alpha\alpha'} \delta^3(\vec{p}-\vec{p}') \qquad (8)$$

Also :

$$a_{k\mu} \Psi_o = \tilde{\Psi}_o \tilde{a}_{k\mu} = o \qquad (9)$$

Since b_α, b^*_β, a are annihilation, b^*_α, b_β, $\tilde{a}$ are creative operators.

$$b_{p\alpha} \Psi_o = \tilde{\Psi}_o b^*_{p\alpha} = o \qquad (10)$$

$$b^*_{p\beta} \Psi_o = \tilde{\Psi}_o b_{p\beta} = o$$

These equations together with (7), (8) are used to calculate the matrix element (2)

Let $G_n(x)$ denote

$$G_n(x_1 x_2 .. x_n) = (\Psi_f, P(H(x_1) \dots H(x_n)) \Psi_i) \qquad (11)$$

then $$P_{if} = \sum_n \left(\frac{-i}{\hbar}\right)^n \frac{1}{n!} \int dx_1 .. dx_n \, G_n(x_1 \dots x_n) \qquad (12)$$

Since $H(x) = j_\mu A_\mu = i e \Psi \gamma_\mu A_\mu \psi$ (13)

we can express G_n as a product $(ie)^n G_n^{(e)} . G_n^{(p)}$

$$G_n(x_1 .. x_n) = (ie)^n G_n^{(e)} \begin{pmatrix} x_1 \dots x_n \\ \mu_1 \dots \mu_n \end{pmatrix} G_n^{(p)} \begin{pmatrix} x_1 \dots x_n \\ \mu_1 \dots \mu_n \end{pmatrix} \qquad (14)$$

where

$$G_n^{(e)} \begin{pmatrix} x_1 \dots x_n \\ \mu_1 \dots \mu_n \end{pmatrix} = \Big[b^*_{q'_{m'} \beta'_{m'}} \dots b^*_{q'_1 \beta'_1} b_{p'_n \alpha'_n} \dots b_{p'_1 \alpha'_1} P(\bar{\psi}(x_1) \gamma_{v_1} \qquad (15)$$

$$\psi(x_1) .. \bar{\psi}(x_n) \gamma_{v_n} \psi(x_n)) \, b^*_{p_1 \alpha_1} .. b^*_{p_n \alpha_n} b_{q_1 \beta_1} \dots b_{q_m \beta_m} \Big]_o$$

and $$G_n^{(p)} \begin{pmatrix} x_1 .. x_n \\ \mu_1 \dots \mu_n \end{pmatrix} = \langle a_{k'_{r'} \mu'_{r'}} \dots a_{k'_1 \mu'_1} P(A_{v_1}(x_1) .. A_{v_n}(x_n)) \qquad (16)$$

$$\tilde{a}_{k_1 \mu_1} \dots \tilde{a}_{k_n, \mu_n} \rangle_o$$

We start by the expectation value (15) of electron-position functions and operators. Use will be made of the expectation value of a product of anticommuting operators :

$$\langle b_1 b_2 \dots b_n \rangle_o = \sum_{ij} \langle b_{i_1} b_{j_1} \rangle \langle b_{i_2} b_{j_2} \rangle \dots \langle b_{i_k} b_{j_k} \rangle$$

$$\epsilon_{i_1 j_1 \dots i_k j_k} \; (i_r < j_r)$$

$$= \left. \begin{matrix} (12) & (13) & \dots & (1n) \\ & (23) & \dots & (2n) \\ & & \dots & \dots \\ & & & (n-1, n) \end{matrix} \right| - \qquad (17)$$

which is a pfafian in the expectation values of different pairs

$$(ij) = \langle b_i . b_j \rangle$$

Let
$$\langle \Psi_r b'_{pi} \rangle = v'_{ir} \quad \langle b_{pi} \bar{\Psi}_r \rangle = \bar{v}_{ir}$$

$$\langle \Psi_r b^*_{qi} \rangle = u_{ir} \quad \langle b'_{qi} \bar{\Psi}_r \rangle = \bar{u}'_{ir} \qquad (18)$$

$$\langle \bar{\Psi}_r \psi_s \rangle = -\tfrac{1}{2} S^F(rs) \equiv (rs)$$

Hence the expectation value (15) is equal to the pfafian

$$\left|\begin{array}{l}
o \ldots \quad o\; \overline{u}'_{11}\; o\; \overline{u}'_{12}\; \ldots\; \overline{u}'_{1n}\; o \ldots\; o \\
\quad \ldots\ldots \quad - \; - \; - \; - \; - \\
\qquad \overline{u}'_{m+k,1}\; o\; \ldots\; \overline{u}'_{m+k,n}\; o \ldots\; o \\
-v'_{1,1}\; o\; -v'_{1,2} \cdot\; \cdot\; -v'_{1n}\; o\; \; o \ldots\; o \\
-v'_{m,1}\; o\; -v'_{m,2}\; o\; .\; .\; -v'_{m,n}\; o\; .\; o .\; .\; .\; o \\
\quad (1\overline{1})\; o\; (1\overline{2})\; ..\; (1\overline{n})\; o\; ..\; u_{11} u_{21} \ldots u_{l+k,1} \\
\qquad (\overline{1}2)\; o\; (\overline{1}3)\; ..\; \ldots -\overline{v}_{11}\; ..\; -\overline{v}_{l1}\; o \ldots\; o \\
\qquad - \; - \; - \; - \; - \; - \; . \\
\qquad\qquad (n\overline{n})\; o\; ..\; o\; \; u_{1n}\; \ldots u_{l+k,n} \\
\qquad\qquad -\overline{v}_{1n}\; ..\; -v_{ln}\; o\; \; .\; .\; .\; o \\
\qquad\qquad\quad o\; \; .\; \; .\; \; -\; \; .\; o \\
\qquad\qquad\qquad - \; - \; - \\
\qquad\qquad\qquad\qquad o
\end{array}\right|_{-} \qquad (19)$$

This pfafian is in fact the square root of the following antisymmetric determinant :

$$\left|\begin{array}{l}
o \ldots\; o \ldots\; o\; \bar{u}'_{11}\; o\; \bar{u}'_{12}\; \ldots\; \bar{u}'_{1n} \\
.\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; . \\
o ..\; o \ldots\; o\; u'_{m+k,1}\; o\; u'_{m+k,2} \ldots\; u'_{m+k,n}\; o \ldots\; o \\
o \ldots\; o \ldots\; -v'_{1,1}\; o\; -v'_{1,2}\; o\; -v'_{1,n}\; o\; \; o \ldots\; o \\
.\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; . \\
o \ldots \quad -v'_{m,1}\; o\; \; -v'_{m,2}\; o\; \; -v'_{m,n}\; o\; \; \ldots .\; \; o \\
o ..\; o\, v'_{1,1}\; ..\; v'_{m,1}\; o\; (1\overline{1})\; o\; (1\overline{2})\; o ..\; (1\overline{n})\; o ..o u_{11}\; \ldots\; u'_{l+k,1} \\
-\bar{u}'_{11}\; \ldots\; -\bar{u}'_{m+k,1}\; o\; ..o\, (\overline{1}1)\; o\; (\overline{1}2)\; o ..\; (\overline{1}n)\; o\; -\bar{v}_{11}\; .-.\bar{v}_{21}\; o \ldots\; o \\
.\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; . \\
o ..\; o\; -v'_{1n}\; ..\; v'_{m,n}\; o\; -(\overline{1}n)\; \; o\; -(\overline{2}n)\; \; \ldots . (\overline{n}n)\; o ..\; o\; u_{1n}\; ..\; u_{l+k,n} \\
-\bar{u}'_{1n} \ldots\; -\bar{u}'_{m+k,n}\; o ..\; o\; -(1\overline{n})\; o\; \ldots \quad -(n\overline{n})\; o\; -\bar{v}_{1n}\; ..-\bar{v}_{ln}\; o ..\; o \\
o\; \ldots \qquad ..\; \bar{v}_{11}\; .\; .\; .\; .\; \bar{v}_{1n}\; \; o\; .\; .\; .\; .\; o \\
o\; \ldots . \qquad .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; . \\
o\; .\; .\; . \qquad \bar{v}_{l,1} \qquad\qquad \bar{v}_{ln}\; \; o\; .\; .\; .\; .\; o \\
o\; \; .\; \; .\; \; . \qquad -u_{11}\; \; .\; .\; .\; .\; \; -u_{1n}\; o\; \; .\; .\; .\; . \\
.\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; .\; . \\
o\; \; .\; .\; .\; .\; .\; .\; .\; \; -u_{l+k,1}\; \; o \qquad -u_{l+k,n}\; \; o\; \; . \qquad o
\end{array}\right| \qquad (20)$$

By interchanging rows and columns several times we can express this determinant as :

$$\left|\begin{array}{lll}
 & & o \quad \bar{u}' \\
\mathrm{O} & & \qquad \bar{v} \\
 & & u \quad v' \quad S \\
\mathrm{O} & -u & \quad \mathrm{O} \\
 & -v' & \\
-\bar{u}' \quad -\bar{v} \quad S & &
\end{array}\right| \qquad (21)$$

where S stands for the determinant of all (rs), and u that for all u's.

The determinant (21) is a product of two equal determinants, hence the pfafian (19) is exactly equal to the determinant.

$$\left|\begin{array}{ll}
 & u'_{11}\; ..\quad \bar{u}'_{1n} \\
\qquad \mathrm{O} & .\quad .\quad .\quad . \\
 & u'_{m+p,1}\; \ldots\; \bar{u}'_{m+p,n} \\
 & v'_{1,1}\quad \ldots\; \bar{v}_{1,n} \\
u_{11} ..\; \; u_{l+k,1}\; \; ..\; v'_{1,1}\; \; ..\; \; v\text{-}'_{m,1} & \qquad \mathrm{S} \\
u_{1n} ..\; \; u_{l+k,n}\; \; v'_{1,n} \ldots\; v'_{mn} &
\end{array}\right| \qquad (22)$$

For the photon part given by (16), let

$$< a_i\, \mathrm{A}_j > = \overline{x}_{ij} \qquad < \mathrm{A}_i\, \mathrm{A}_j > \equiv < ij > \qquad (23)$$

then it can be shown to be equal to the (hafnian)

$$\left|\begin{array}{r}
o \ldots\quad o\; \overline{x}_{11}\; \overline{x}_{12}\; \ldots\; \overline{x}_{1n}\quad o ..\quad o \\
o ..\; o\; \overline{x}_{21}\quad \ldots\; \overline{x}_{2n}\quad o \ldots\quad o \\
.\; .\; .\; .\; .\; .\; .\; . \\
\overline{x}_{s1}\; \ldots \qquad \overline{x}_{sn}\quad o\quad ..\quad o \\
(12)\; ..\; (1n)\; \; x_{11}\; \ldots\; x_{r1} \\
.\; .\; .\; .\; .\; . \\
(n\text{-}1,n)\; \; x_{1,n-1}\; ..\; x_{r,n-1} \\
o\quad .\quad .\quad o \\
.\quad .\quad . \\
o \quad
\end{array}\right|_{+} \qquad (24)$$

The required expression G_n given by (14) is thus $(ie)^n$ times the product of the determinant (22) by the hafnian (24).

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3. Feynman (1949). *Phys. Rev.* Space time approach to Quantum Electrodynamics. Vol. 76, p. 769.

4. Caianiello, E. R. (1953). *Il Nuovo Cimento* 10, 1634-1652. On Quantum Field Theory.

PROCÈS-VERBAUX
DES SÉANCES PUBLIQUES

SÉANCE PUBLIQUE DU LUNDI 10 NOVEMBRE 1958

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. Mostafa Nazif, *président.*
Ch. Avierinos, *vice-président.*
Mostafa Amer, *vice-président.*
Bishr Farès, *secrétaire général.*
Sami Gabra, *trésorier-bibliothécaire.*
L.-A. Christophe, *secrétaire général adjoint.*

Membres titulaires : R. P. G. C. Anawati ; MM. Ch. Kuentz, P. Balog, Osman R. Rostem, Elhamy Greiss, Hamed Zaki, A. Alfieri, Mansour Fahmy, Mourad Kamel, Ismail Rateb.

Membre correspondant : M. Ibrahim el-Mouélhi.

Assistent à la séance : Mmes H. Akaoui, A. Khayrat, G. Tassmani, N. Bébaoui ; MM. Mohamed Hassanein, Abdel-Halim Montasser, Zaki Ibrahim, E. Combe.

1. Le Secrétaire général donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 19 Mai 1958, qui est approuvé.

2. Le Secrétaire général présente les livres et tirés à part offerts à l'Institut par MM. Aly Shaféi, Zaher Riad, Hassan Mahmoud, Abdel-Raouf Youssef, Mohamed Mostafa, Bishr Farès, Honziaux et Battiau, P. Quézel, A. Guerreiro et A. Alfieri, ainsi que par l'Académie Royale de Belgique et l'Université de Madrid.

Le Président remercie les donateurs.

3. Le Président félicite le Dr Paul Balog pour sa nomination au titre de membre honoraire au Bureau de la Commission internationale de Numismatique qui fait partie, à La Haye, du Comité international des Sciences historiques.

4. Le Dr Hamed Zaki lit une notice nécrologique sur Mohamed Kamel Moursi, ancien membre titulaire.

5. Le Dr Bishr Farès lit sa communication : «*Quatre images arabes : L'Horloge du palais. Trois talismans*» (avec projection).

6. Le Dr Abdel-Halim Montasser lit sa communication (préparée conjointement avec le Dr Sabri Elwan) «*Soil Microflora in relation to Distribution and Growth of Desert Plants*».

MM. Hamed Zaki et Mostafa Nazif prennent la parole pour présenter quelques observations.

Le Président lève la séance à 7 heures 20 p.m.

Le Secrétaire général
Dr Bishr Farès

SÉANCE PUBLIQUE DU LUNDI 1er DÉCEMBRE 1958

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. Mostafa Nazif, *président.*
Ch. Avierinos, *vice-président.*
Mostafa Amer, *vice-président.*
Bishr Farès, *secrétaire général.*
L.-A. Christophe, *secrétaire général adjoint.*

Membres titulaires : R. P. Georges Anawati, MM. Elhamy Greiss, Mansour Fahmy, Mohamed Mostafa, Osman Ghaleb, P. Balog, A. Alfieri.

Membre associé : Hassan Abdel-Wahab.

Assistent à la séance : Mmes. H. Balog et M. Jungfleisch. MM. Abdel-Halim Montasser, Banhaoui, Chalaby, Rostem, Fawzy Amer, Mohamed Aboul-Fath, Emile Chenouda, William Rizkallah, Youssef Hassan, Farès Nabih, Abdel-Halim Kamel, Youssef Nahas, Ezz el-Dine Said.

1. Le Secrétaire général donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 10 novembre 1958 qui est approuvé.

2. Le Secrétaire général présente un ouvrage reçu de l'Université de Yale (New-Haven).

Le Président remercie la dite Université.

3. Le Dr Paul Balog lit sa notice nécrologique sur Marcel Jungfleisch.

4. Le Dr Ahmed Hammad El-Hussaini lit sa communication : « *On the Nature of certain Pear-Shaped Cells in the Intestinal Epithelium of Fish* ».

Le Dr Mostafa Nazif prend la parole pour présenter quelques observations ; l'orateur s'étend alors sur certains points.

Le Président lève la séance à 7 heures p.m.

Le Secrétaire général
Dr Bishr Farès

SÉANCE PUBLIQUE DU LUNDI 12 JANVIER 1959

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. Mostafa Nazif, *président.*
Ch. Avierinos, *vice-président.*
Mostafa Amer, *vice-président.*
Bishr Farès, *secrétaire général.*

Excusés : MM. Sami Gabra, *trésorier-bibliothécaire ;* L.-A. Christophe, *secrétaire général adjoint.*

Membres titulaires : MM. Elhamy Greiss, A. Alfieri, P. Balog, J.-Ph. Lauer.

Assistent à la séance : MM. Salama Tosson, Mohamed H. Zein el-Dine el-Gibali, Sami A. Sobhi, Mohamed A. Rachid, Hassan Abdel-Wahab, Mohamed H. Sallam, El-Hanafi A. Sadek, Fayez Salib, Abdel-Halim el-Domiati, Bichay G. Bichay, Mohamed Nessim.

1. Le Secrétaire général donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 1er décembre 1958, qui est approuvé.

2. Le Secrétaire général présente des ouvrages offerts à l'Institut par MM. Nicolas Ziyadeh et Jamal Muhassib.

Le Président remercie les donateurs.

3. Le Dr Salama Tosson lit sa communication : « *The Dispersion of Birefringence in Minerals and the apparent Width of the Isogyre* ».

M. Mostafa Nazif prend la parole pour présenter quelques observations.

4. Le Dr Mohamed Helmy el-Gamal lit sa communication : « *The Effect of Degree of Fineness of Gypsum on Reclamation of Alkali Soils* ».

MM. Mostafa Amer, Elhamy Greiss et Salama Tosson prennent la parole pour présenter quelques observations.

Le Président lève la séance à 6 heures 55 p.m.

Le Secrétaire général
Dr Bishr Farès

SÉANCE PUBLIQUE DU LUNDI 2 FÉVRIER 1959

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. Ch. Avierinos, *vice-président.*
Bishr Farès, *secrétaire général.*
Sami Gabra, *trésorier-bibliothécaire.*
L.-A. Christophe, *secrétaire général adjoint.*

Excusés : MM. Mostafa Nazif, *président* et Mostafa Amer, *vice-président.*

Membres titulaires : MM. ELHAMY GREISS, OCTAVE GUÉRAUD, A. ALFIERI, P. BALOG, MANSOUR FAHMY, ISMAIL RATIB.

Membres correspondants : MM. ABDEL-MOHSEN EL-KHASHSHAB, G. MICHAÏLIDIS.

Assistent à la séance : Mmes H. Balog, H. Akkaoui, Gazibiah Sedki, Fakhri, Dr Sumayya Ahmad Fahmi ; MM. Naguib Negm Karam, Rizkalla Nakhla, Adel el-Ghadbane, Mohamed Mounir Abdel Kérim, Hassan Abdel-Wahab, Sanad Basta, Dr Youssef Liéto Youssef, Youssef Zaki, Combe, Ebeid.

1. Le SECRÉTAIRE GÉNÉRAL donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 12 janvier 1959, qui est adopté.

2. Le SECRÉTAIRE GÉNÉRAL annonce que le professeur Ch. Avierinos, vice-président de l'Institut, a été élu, le 7 novembre 1958, membre correspondant de l'Académie d'Athènes, section des sciences positives.

3. Le VICE-PRÉSIDENT annonce que deux membres titulaires, le Dr Mansour Fahmy et le Dr Bishr Farès, ont été invités par le Ministre de l'Instruction publique de la Principauté de Koweit, le Cheikh Abdallah Al-Djâbir, à participer au IVe Congrès des écrivains arabes, tenu au mois de décembre 1958.

4. Le Dr Bishr Farès lit sa communication : « *Un tour au Koweit* » (avec projection et audition). Le Prof. P. Balog prend la parole pour présenter quelques observations.

5. Le Professeur Paul Balog lit sa communication : « *Un dinar d'imitation ayyoubite frappé par les Croisés au nom de Saladin* » (avec projection).

6. Le Dr R. N. Sedra, en son nom et en celui de M. L. Sefein, lit leur communication : « *Relation between Solar Radio-Emission and the Earth's Magnetic Field* ».

Le VICE-PRÉSIDENT lève la séance à 7 heures p.m.

Le Secrétaire général
DR BISHR FARÈS

SÉANCE PUBLIQUE DU LUNDI 9 MARS 1959

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. CH. AVIERINOS, *vice-président.*
MOSTAFA AMER, *vice-président.*
BISHR FARÈS, *secrétaire général.*
L.-A. CHRISTOPHE, *secrétaire général adjoint.*

Excusés : MM. MOSTAFA NAZIF, *président ;* SAMI GABRA, *trésorier-bibliothécaire.*

Membres titulaires : MM. MOURAD KAMEL, ELHAMY GREISS, A. ALFIERI.

Membres correspondants : MM. HASSAN ABDEL-WAHAB, ABDEL-MOHSEN EL-KHASHSHAB, ABDEL-RAHMAN ZAKI.

Assistent à la séance : MM. Sayed Salem, Shihata Ibrahim, Henri Zaccour, Hassan Tawfiq, Mohamed H. Sadek, Farouk M. el-Ramli, Raouf Habib, Abdalla Hassan, Labib Habashi, Mohamed Osman, Youssef A. Abdou, Abdel-Razek Shedid, Marzouk Sobhi, Yassine Abdalla, Fouad Kamel, Aziz S. el-Moawwad, Hassan S. Ahmed, Abdel-Monem el-Sayed, Ahmed el-Henedi, Abdallah Latif Ibrahim, Atiyah.

1. Le SECRÉTAIRE GÉNÉRAL donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 2 février 1959, qui est approuvé.

2. Le SECRÉTAIRE GÉNÉRAL présente quelques ouvrages reçus en donation de la part de Mme Sumayya A. Fahmi et M. A. Alfieri.

Le VICE-PRÉSIDENT Avierinos remercie les donateurs.

3. M. Hassan Abdel-Wahab lit sa communication : « *La Khanka et le mausolée de Farag Ibn-Barkouk au désert de Kaït-Bay* » (avec projection).

Le Dr Bishr Farès prend la parole pour présenter quelques observations.

Le Vice-président lève la séance à 7 heures p.m.

Le Secrétaire général
Dr Bishr Farès

SÉANCE PUBLIQUE DU JEUDI 21 MAI 1959

La séance est ouverte au siège de l'Institut à 6 heures p.m.

Sont présents :

Bureau : MM. Ch. Avierinos, *vice-président.*
Mostafa Amer, *vice-président.*
Bishr Farès, *secrétaire général.*

Excusés : MM. Mostafa Nazif, *président ;* Sami Gabra, *trésorier-bibliothécaire ;* L.-A. Christophe, *secrétaire général adjoint.*

Membres titulaires : MM. A. Alfieri, Sainte-Fare Garnot, Kamel O. Ghaleb, Mohamed Mostafa, Mourad Kamel, Elhamy Greiss, P. Balog, R. P. G. Anawati.

Membres correspondant : M. Ibrahim el-Mouélhi.

Assistent à la séance : MM. Salah el-Dine S. Hashish, Afaf Sabri, Amine R. Gindi, El-Chazli Mohamed el-Chazli, Mohamed Ammar, Mahmoud Bakri.

1. Le Secrétaire général donne lecture, dans les deux langues arabe et française, du procès-verbal de la séance publique du 9 mars 1959, qui est approuvé.

2. Le Sécretaire général présente une gerbe d'ouvrage scientifiques offerts à l'Institut par M. Alfieri, membre titulaire.

Le Vice-président remercie le donateur.

3. Le Dr Amine Riad Gindy lit sa communication : « *The Radioactivity of late Precambrian Dykes and other minor Intrusions from the Aswan and Qoseir Districts, Egypt* ».

4. Le Dr Afaf Sabri lit sa communication : « *Explicit Solution of Dyson's Equations in Quantum Electrodynamics* ».

5. Le Dr Salah el-Dine al-Sayed Hashish lit sa communication : « *The effect of Heparin on Rb^{86} Exchangeability in Muscle* ».

Le Vice-président lève la séance à 7 heures 15 p.m.

Le Secrétaire général
Dr Bishr Farès

RAPPORT

SUR LES ACTIVITÉS DE L'INSTITUT D'ÉGYPTE

SESSION 1958-1959

Séances. — L'Institut a tenu, au cours de cette session, six séances au cours desquelles ont été lues douze communications, traitant des sciences, des arts et des lettres.

Échange de Publications. — L'Institut a échangé ses publications avec environ 250 sociétés savantes égyptiennes et étrangères.

Bibliothèque. — La Bibliothèque a reçu en donation, pendant la session, 335 ouvrages, outre les périodiques qu'elle reçoit, par voie d'échange, des sociétés savantes à travers le monde.

Le répertoire de la Bibliothèque accuse actuellement un total de 41.311 ouvrages.

Congrès. — Le Dr. Bishr Farès, Secrétaire général de l'Institut, et le Dr. Mansour Fahmy, membre titulaire, ont, sur l'invitation du Gouvernement koweitien, participé au IV[e] Congrès des Hommes de Lettres Arabes, qui s'est tenu au Koweit en décembre 1958.

Tableau. — Le Dr. Paul Balog, membre titulaire de l'Institut, a été nommé membre honoraire de la Commission Internationale de Numismatique, à la Haye.

Le Prof. Ch. Avierinos, membre titulaire de l'Institut a été nommé membre correspondant de l'Académie d'Athènes.

Pendant la session, l'Institut a eu le regret de perdre Marcel Jungfleisch, membre titulaire.

A la clôture de la session, l'Institut comptait :

45 membres titulaires, sur 50 sièges ;
48 membres associés, sur 50 sièges ;
24 membres correspondants, sur 50 sièges.

EXTRAIT DU RAPPORT DU CENSEUR

SUR L'EXERCICE 1958/1959

(DU 1ER JUILLET 1958 AU 30 JUIN 1959)

ÉTAT DES RECETTES ET DÉPENSES

Recettes.

	L.E.	Mill.
Subvention du Ministère de l'Éducation	2495	—
Vente de publications	150	510
Intérêts sur dépôt en banque	32	420
Perceptions diverses	47	524
	2725	454

Dépenses.

	L.E.	Mill.
Traitements et gratifications	769	723
Honoraires du Censeur	20	290
Frais de déplacement	78	—
Impression et fournitures	32	350
Cotisation à la Fédération Scientifique Egyptienne	5	—
Frais de poste	6	313
Téléphone	16	250
Eau et électricité	8	708
Uniformes des plantons	9	—
Matériel courant et réparations	13	485
Frais divers	17	185
Frais bancaires	10	996
Créances irrécouvrables	13	854
Excédent des recettes sur les dépenses	1724	300
	2725	454

	L.E.	Mill.
Recettes	2725	454
Dépenses	1001	154
Excédent des recettes sur les dépenses	1724	300

Le Censeur,
Fayez Bébaoui
Regist. n° 158

BUREAU DE L'INSTITUT

POUR L'ANNÉE 1959

MM. Mostafa Nazif, *président.*
Ch. Avierinos, Mostafa Amer, *vice-présidents.*
Bishr Farès, *secrétaire général.*
Sami Gabra, *trésorier-bibliothécaire.*
L.-A. Christophe, *secrétaire général adjoint.*

COMITÉ DES PUBLICATIONS

(outre les membres du bureau qui en font partie de droit)

MM. A. Alfieri.
Mourad Kamel.
G. C. Anawati, o. p.
Mohamed Mostafa.

LISTE

DES

MEMBRES TITULAIRES DE L'INSTITUT D'ÉGYPTE

AU 30 JUIN 1959

La date qui suit le nom est celle de nomination ; le nom entre parenthèses est celui du prédécesseur.

1RE SECTION.

LETTRES, BEAUX-ARTS ET ARCHÉOLOGIE.

AHMED LOUTFI EL-SAYED, 6 décembre 1915 (Mgr Kyrillos Macaire).
TAHA HUSSEIN, 7 avril 1924 (Ahmed Kamal Pacha).
KUENTZ (Charles), 21 février 1938 (P. Lacau).
SAMI GABRA, 20 janvier 1941 (Comte Ch. de Serionne).
GUÉRAUD (Octave), 9 mars 1942 (F. Peter).
MOHAMED CHAFIK GHORBAL, 16 janvier 1947 (Rév. P. P. Sbath).
SOLIMAN AHMED HUZAYYIN, 23 avril 1947 (Ahmed Issa Bey).
BISHR FARÈS, 5 avril 1948 (Cheikh Mostafa Abdel-Razek).
MOSTAFA AMER, 17 mai 1948 (Rév. P. Paul Bovier-Lapierre).
OSMAN RIFKI ROSTEM, 14 mai 1949 (D. Pachundaki).
MOURAD KAMEL, 22 avril 1950 (Togo Mina).
ANAWATI (Rév. P. Georges C.), 3 février 1951 (Abdel-Méguid Omar Pacha).
LAUER (Jean-Philippe), 3 février 1951 (M. de Wée).
GOBY (Jean-Edouard), 22 mai 1952 (J. I. Craig).
CHRISTOPHE (Louis-A.), 1er mars 1954 (Et. Drioton).
HICKMANN (Hans), 1er mars 1954 (G. Wiet).
MOHAMED MOSTAFA, 3 mai 1954 (Mohamed Mahmoud Khalil).
SAINTE-FARE GARNOT (Jean), 2 mai 1955 (G. V. Anrep).

2E SECTION.

SCIENCES HUMAINES.

LEVI (Isaac G.), 4 décembre 1916 (J. Barois).
MANSOUR FAHMY, 3 avril 1922 (J. Vaast).
ARANGIO-RUIZ (Vincenzo), 6 février 1933 (A. Politis).
CATTAUI (René), 10 février 1941 (W. F. Hume).
ABDEL HAMID BADAWI, 5 avril 1948 (Farid Boulad Bey).
HAMED ZAKI, 12 janvier 1952 (O. H. Little).

3E SECTION.

SCIENCES PHYSIQUES ET MATHÉMATIQUES.

HURST (Harold Edwin), 5 décembre 1921 (Mohamed Magdi Pacha).
KAMEL OSMAN GHALEB, 1er février 1937 (M. Chahine Pacha).
HUSSEIN SIRRY, 21 février 1938 (Ismail Sirry Pacha).
MOHAMED REDA MADWAR, 4 mars 1940 (J. Cuvillier).
ISMAIL RATIB, 6 décembre 1948 (A. Mochi).
MOSTAFA NAZIF, 22 mai 1952 (Th. de Comnène).
AHMED RIAD TOURKY, 4 avril 1955 (S. Mihaeloff).

4E SECTION.

SCIENCES BIOLOGIQUES.

WILSON (William Hawkins), 7 décembre 1908 (Commandant Léon Vidal).
GORGI SOBHY, 3 février 1936 (Ahmed Zaki Pacha).
AVIERINOS (Christo), 6 mars 1944 (Th. Papayoannou).
MOHAMED KAMEL HUSSEIN, 2 avril 1945 (P. Kraus).
MOHAMED SOBHY, 11 mars 1946 (M. Meyerhof).
MAHMOUD IBRAHIM ATTIA, 4 février 1946 (G. Ferrante).
ALFIERI (Anastase), 6 mars 1947 (U. Ricci).

HUSSEIN FAOUZĪ, 8 mars 1948 (Ali Pacha Ibrahim).
MOSSERĪ (Henri V.), 8 mars 1948 (A. Lucas).
GODEL (Roger), 5 avril 1948 (L. Balls).
BALOG (Paul), 19 novembre 1949 (A. Sammarco).
GHALIOUNGUI (Paul), 22 mai 1952 (G. W. Murray).
ELHAMY GREĪSS, 1er mars 1954 (Saadallah Madwar).
AHMED EL-HALAWANĪ, 4 avril 1955 (A. J. Boyé).

LISTE

DES

MEMBRES ASSOCIÉS

AU 30 JUIN 1959

La date qui suit le nom est celle de l'inscription sur cette liste ; elle n'indique pas nécessairement l'antériorité d'appartenance à l'Institut d'Egypte, car plusieurs membres associés étaient auparavant, pendant leur résidence en Egypte, des membres titulaires.

MM. MRAZEK (Louis), 19 janvier 1914.
VRÉGILLE (Rév. P. Pierre de), 14 janvier 1918.
BRUMPT (Emile), 7 janvier 1924 (France).
BARTHOUX (Jules), 12 janvier 1925 (France).
CHARLES-ROUX (François), 12 janvier 1925 (France).
FLEURI (Gaston), 17 janvier 1927 (France).
LALANDE (André), 9 janvier 1928 (France).
ARVANITAKIS (Georges), 13 mai 1929 (Grèce).
LOTSY (Gerhard Oswald), 4 mai 1931 (Maroc).
POLITIS (Athanase G.), 9 mai 1932.
ROYER (Etienne), 1er mai 1933 (France).
BRECCIA (Evaristo), 7 mai 1934 (Italie).
LACAU (Pierre), 10 mai 1937 (France).
GHIGI (Alessandro), 21 février 1938 (Italie).
HADAMARD (Jacques), 21 février 1938 (France).
GROHMANN (Adolf), 21 février 1938 (Autriche).
ANDREAE (Charles), 21 février 1938 (Suisse).
CUVILLIER (Jean), 5 décembre 1938 (France).
BELL (Sir Harold Idris), 4 mars 1940 (Grande-Bretagne).
DONTAS (Spiro), 4 mars 1940 (Grèce).
GERULANOS (Marius), 4 mars 1940 (Grèce).
MINOST (Emile), 13 mai 1946 (France).

VAN WIJNGAARDEN (William Dirk), 5 février 1947 (Hollande).
GIBB (Hamilton Alexander Rosskeen), 5 février 1947 (Grande-Bretagne).
VOLTERRA (Eduardo), 5 février 1947 (Italie).
MASSIGNON (Louis), 5 février 1947 (France).
GARDINER (Sir Alan H.), 5 février 1947 (Grande-Bretagne).
CERNY (Jaroslav), 9 février 1948 (Grande-Bretagne).
BARRIOL (Alfred), 9 février 1948 (France).
BALLS (Lawrence), 5 avril 1948 (Grande-Bretagne).
FLEURE (Herbert John), 4 février 1950 (Grande-Bretagne).
LITTLE (Otway Henry), 20 mai 1950 (Sud-Afrique).
WÉE (Maurice de), 20 mai 1950 (Belgique).
DAWSON (Warren Royal), 3 février 1951 (Grande-Bretagne).
HASSAN HOSNI ABDEL WAHAB, 3 février 1951 (Tunisie).
JANSSEN (Jozef), 3 février 1951 (Hollande).
MONTET (Pierre), 3 février 1951 (France).
GARCIA-GOMEZ (Emilio), 19 février 1952 (Espagne).
MURRAY (George William Welch), 19 février 1952 (Grande-Bretagne).
DRIOTON (Etienne), 2 novembre 1953 (France).
WIET (Gaston), 2 novembre 1953 (France).
MILES (George Carpenter), 8 février 1954 (U. S. A.).
MONTEL (Paul), 8 février 1954 (France).
PORTEVIN (Albert Marcel Germain René), 8 février 1954 (France).
VAN DE WALLE (Baudouin), 8 février 1954 (Belgique).
BOYÉ (André Jean), 6 décembre 1954 (France).
SANDER-HANSEN (Constantin Emil), 7 février 1955 (Danemark).

LISTE

DES

MEMBRES CORRESPONDANTS

AU 30 JUIN 1959

MM. CALLIMACHOS (Rév. Panos Demetrios), 9 janvier 1912 (U. S. A.).
DALLONI (Marius), 10 février 1936 (Algérie).
DESIO (Ardito), 10 février 1936 (Italie).
DOLLFUS (Robert Ph.), 10 février 1936 (France).
DONCIEUX (Louis), 1er février 1937 (France).
MONNEROT-DUMAINE (Marcel), 4 mars 1940 (France).
JABÈS (Raymond), 6 mars 1947 (France).
DORESSE (Jean), 19 février 1949 (France).
SEELE (Keith C.), 19 février 1949 (U. S. A.).
BRESCIANI-TURRONI (Costantino), 4 février 1950 (Italie).
FONTAINE (Alfred L.), 4 février 1950 (France).
ABDEL-FATTAH HELMY, 3 février 1951 (R. A. U.).
ABDEL-MOHSEN EL-KHASHSHAB, 3 février 1951 (R. A. U.).
ABDEL-NABI EL-NAHAS, 3 février 1951 (R. A. U.).
IBRAHIM EL-MOUÉLHY, 3 février 1951 (R. A. U.).
MICHAÏLIDIS (Georges), 3 février 1951 (R. A. U.).
MOHAMED MAHDI, 3 février 1951 (R. A. U.).
SCHWARTZ (Jacques), 3 février 1951 (France).
FRIEDINGER-PRANTER (Robert), 19 février 1952 (Autriche).
ABDEL-RAHMAN ZAKI, 19 février 1952 (R. A. U.).
BADAWY (Alexandre), 19 février 1952 (R. A. U.).
GANDILHON (René), 8 février 1954 (France).
HASSAN ABDEL WAHAB, 8 février 1954 (R. A. U.).
KOMORZYNSKI (Egon), 8 février 1954 (Autriche).

مستخرج من تقرير مراقب الحسابات عن نصف سنة مالية
من ١ / ٧ / ١٩٥٩ إلى ٣١ / ١٢ / ١٩٥٩

حساب الايرادات والمصروفات

المصروفات

مليم	جنيه	
—	٣٠٦	مرتبات ومكافآت .
٧٠٠	٢٠	أتعاب المراقبة .
—	٥٨	بدل انتقال .
٥٣٥	١٦	مطبوعات وأدوات .
٦٠٠	١٩٥	دفاتر وتجليد كتب .
—	٣٠	تصميم الشارة الجديدة .
٨٨٨	—	بريد وبرق .
١٢٠	٨	تليفون .
٥٥٤	٩	مياه ونور .
٧٨٥	٤	أدوات وتصليحات .
٢٣٥	١٥	مصاريف متنوعة .
٦٧٤	٦	مصاريف بنك .
١٣٩	١٣٧٩	صافى الإيرادات .
٨٣٠	٢٠٥٠	

الإيرادات

مليم	جنيه	
٩٤٠	١٩٩٥	إعانة وزارة التربية .
٨٣٠	٣٦	إيرادات المطبوعات .
٦٠	١٨	فوائد إيداع .
٨٣٠	٢٠٥٠	

	مليم جنيه
الإيرادات	٢٠٥٠,٨٣٠
المصروفات	٦٧١,٦٩١
زيادة الإيرادات على المصروفات	١٣٧٩,١٣٩

مراقب الحسابات

فايز بباوى

س . م . م . ١٥٨

أعضاء مراسلون :

السيد / ابراهيم المويلحى .

الجمهور :

السادة : صلاح الدين حشيش ، عفاف صبرى ، أمين رياض جندى ، الشاذلى محمد الشاذلى ، محمد عمار ، محمود بكرى .

١ — تلا السكرتير العام محضر الجلسة العلنية المنعقدة فى ٩ مارس سنة ١٩٥٩ باللغتين العربية والفرنسية ، وتمت الموافقة عليه .

٢ — عرض السكرتير العام مجموعة من الكتب العلمية مهداة إلى المجمع من السيد / أ. ألفييرى ، العضو العامل .

شكر نائب الرئيس صاحب الإهداء .

٣ — تلا الدكتور أمين رياض جندى بحثه : « إشعاعات الصخور النارية المتأخرة فى العصر السابق للكمبرى بمنطقتى أسوان والقصير » .

٤ — تلا الدكتور عفاف صبرى بحثه : « حل معادلات ديسون فى إلكتروديناميكا الكم » .

٥ — تلا الدكتور صلاح الدين السيد حشيش بحثه : « تأثير الهيبارين فى متبادلية الروبيديوم ٨٦ فى العضلات » .

ورفع نائب الرئيس الجلسة الساعة السابعة والدقيقة ١٥ مساء .

السكرتير العام

الدكتور بشر فارس

مستخرج من تقرير مراقب الحسابات عن السنة المالية ١٩٥٨/١٩٥٩

من ١ / ٧ / ١٩٥٨ إلى ٣٠ / ٦ / ١٩٥٩

حساب الايرادات والمصروفات

المصروفات			الإيرادات		
مليم	جنيه		مليم	جنيه	
٧٢٣	٧٦٩	مرتبات ومكافآت .	—	٢٤٩٥	إعانة وزارة التربية .
٢٩٠	٢٠	أتعاب المراقبة .	٥١٠	١٥٠	إيراد المطبوعات .
—	٧٨	بدل انتقال .	٤٢٠	٣٢	فوائد إيداع .
٣٥٠	٣٢	مطبوعات وأدوات .	٥٢٤	٤٧	متحصلات متنوعة .
—	٥	اشتراك فى الاتحاد العلمى المصرى .			
٣١٣	٦	بريد وبرق .			
٢٥٠	١٦	تليفون .			
٧٠٨	٨	مياه ونور .			
—	٩	كساوى .			
٤٨٥	١٣	أدوات وتصليحات .			
١٨٥	١٧	مصاريف متنوعة .			
٩٩٦	١٠	مصاريف بنك .			
٨٥٤	١٣	مبالغ معدومة (ذمم غير محصلة) .			
٣٠٠	١٧٢٤	صافى الإيرادات .			
٤٥٤	٢٧٢٥		٤٥٤	٢٧٢٥	

	مليم جنيه
الإيرادات	٤٥٤,٢٧٢٥
المصروفات	١٥٤,١٠٠١
زيادة الإيرادات على المصروفات	٣٠٠,١٧٢٤

مراقب الحسابات

فايز بباوى

س . م . م . ١٥٨

محضر الجلسة العلنيـة المنعقدة يوم الاثنين ٩ مارس سـنة ١٩٥٩

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

خرستو أفيرينوس . . . } نائبا الرئيس
مصطفى عامر . . . . . }
بشر فارس . . . . السكرتير العام
ل . أ . كرستوف . . . السكرتير العام المساعد

واعتذر عن التغيب / السيدان مصطفى نظيف ، الرئيس . وسامى جبره ، أمين الصندوق والمكتبة .

أعضاء عاملون :

السادة : مراد كامل ، إلهامى جريس ، أ . ألفييرى .

أعضاء مراسلون :

السادة : حسن عبد الوهاب ، عبد المحسن الخشاب ، عبد الرحمن زكى .

الجمهور :

السادة : سيد سالم ، شحاته ابراهيم ، هنرى زكور ، حسن توفيق ، محمد حلمى صادق ، فاروق محمد الرملى ، رؤوف حبيب ، عبد الله حسن ، لبيب حبشى ، محمد عثمان ، يوسف أحمد عبده ، عبد الرازق شديد ، مرزوق صبحى ، يس عبد الله ، فؤاد كامل ، عزيز سوريال المعوض ، حسن سيد أحمد ، عبد المنعم السيد ، أحمد الهنيدى ، عبد الله ابراهيم ، عطيه .

١ – تلا السكرتير العام باللغتين العربية والفرنسية محضر الجلسة العلنية المنعقدة فى ٢ فبراير سنة ١٩٥٩ ، وتمت الموافقة عليه .

٢ – عرض السكرتير العام حفنة من الكتب واردة إلى المجمع هدية من السيدة / سمية أحمد فهمى ، والسيد / أ . ألفييرى .

شكر نائب الرئيس الأستاذ أفيرينوس صاحبى الإهداء .

٣ – تلا السيد / حسن عبد الوهاب بحثه : « خانقاه الناصر فرج بن برقوق ومقبرته فى صحراء قايتباى » . وعلق عليها الدكتور بشر فارس .

ورفع نائب الرئيس الجلسة الساعة السابعة مساء .

السكرتير العام

الدكتور بشر فارس

محضر الجلسة العلنية المنعقدة يوم الخميس ٢١ مايو سنة ١٩٥٩

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

خرستو أفيرينوس . . . } نائبا الرئيس
مصطفى عامر . . . . . }
بشر فارس . . . . السكرتير العام

واعتذر عن التغيب السادة : مصطفى نظيف ، الرئيس . وسامى جبره ، أمين الصندوق والمكتبة . و ل . كرستوف ، السكرتير العام المساعد .

أعضاء عاملون :

السادة : محمد مصطفى ، مراد كامل ، إلهامى جريس ، أ . ألفييرى ، ب . بالوج ، الأب جورج قنواتى ، سانت فار جارنو ، كامل عثمان غالب .

محضر الجلسة العلنية المنعقدة يوم الاثنين ٢ فبراير سنة ١٩٥٩

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

خ . أفيرينوس . . . . نائب الرئيس
بشر فارس . . . . . . السكرتير العام
سامى جبره . . . . . . أمين الصندوق والمكتبة
ل . كريستوف . . . . السكرتير العام المساعد

واعتذر عن التغيب : السيدان / مصطفى نظيف ، الرئيس . ومصطفى عامر ، نائب الرئيس .

أعضاء عاملون :

السادة : إلهامى جريس ، أوكتاف جيرو ، أ . ألفييرى ، بول بالوج ، منصور فهمى ، اسماعيل راتب .

أعضاء مراسلون :

السيدان / عبد المحسن الخشاب ، و ج . ميخائيليدس .

الجمهور :

السيدات : ه . بالوج ، ه . عكاوى ، جاذبية صدقى ، مدام فخرى ، الدكتورة سمية أحمد فهمى .

والسادة : نجيب نجم كرم ، رزق الله نخله ، عادل الغضبان ، محمد منير عبد الكريم ، حسن عبد الوهاب ، سند بسطا ، يوسف ليتويوسف ، يوسف زكى ، كومب ، عبيد .

١ — تلا السكرتير العام محضر الجلسة العلنية المنعقدة فى ١٢ يناير سنة ١٩٥٩ باللغتين العربية والفرنسية ، وتمت الموافقة عليه .

٢ — أعلن السكرتير العام أن الأستاذ الدكتور خرستو أفيرينوس ، نائب رئيس المجمع ، أنتخب عضواً مراسلا لأكاديمية أثينا ، قسم العلوم الوضعية فى ٧ نوفمبر سنة ١٩٥٨

٣ — أعلن نائب الرئيس حضور عضوين عاملين من المجمع ، هما الدكتور منصور فهمى والدكتور بشر فارس ، المؤتمر الرابع لأدباء العرب بالكويت فى شهر ديسمبر سنة ١٩٥٨ بدعوة خاصة من سمو وزير معارف الكويت الشيخ عبد الله الجابر .

٤ — تلا الدكتور بشر فارس بحثه : « نسيم من الكويت » (مع عرض صور وسماع موسيقى) . علّق عليها الأستاذ بول بالوج .

٥ — تلا الأستاذ بول بالوج بحثه : « دينار أيوبى مقلد ضربه الصليبيون باسم صلاح الدين » ، (مع عرض صور) .

٦ — تلا الدكتور رزق الله نخله سدره عنه وعن السيد / لويس سيفين بحثهما : « العلاقة بين الاشعاع اللاسلكى للشمس والمجال المغنطيسى للأرض » .

ورفع نائب الرئيس الجلسة الساعة السابعة مساء .

السكرتير العام

الدكتور بشر فارس

١ — تلا السكرتير العام محضر الجلسة العلنية المنعقدة فى ١٠ نوفمبر سنة ١٩٥٨ باللغتين العربية والفرنسية ، وتمت الموافقة عليه .

٢ — عرض السكرتير العام كتاباً وارداً إلى المجمع هدية من جامعة « ييل » (نيوهافن) الأمريكية .

شكر الرئيس الجامعة صاحبة الإهداء .

٣ — ألقى الدكتور بول بالوج كلمة تأبين فى المرحوم مارسيل يونجفلايش ، عضو المجمع السابق .

٤ — ألقى الدكتور أحمد حماد الحسينى بحثه : « حول طبيعة بعض الخلايا الكمثرية الشكل فى الطلائية المعوية للأسماك » . علّق على هذا البحث الأستاذ مصطفى نظيف فأفاض صاحب البحث فى عرض بعض المسائل .

ورفع الرئيس الجلسة الساعة السابعة مساء .

السكرتير العام

الدكتور بشر فارس

محضر الجلسة العلنية المنعقدة يوم الاثنين ١٢ ينـــاير سنة ١٩٥٩

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

مصطفى نظيف . . . . الرئيس

خ . أفيرينوس . . . . } نائبا الرئيس

مصطفى عامر . . . . . }

بشر فارس . . . . . . السكرتير العام

واعتـــذر عن التغيب السادة : سامى جبره ، أمين الصندوق والمكتبـــة . و ل . كرستوف ، السكرتير العام المساعد .

أعضاء عاملون :

السادة : إلهامى جريس ، أ . ألفييرى ، ب . بالوج ، ج . ف . لاور .

الجمهور :

السادة : سلامه طوسون ، محمد حلمى الجبالى ، سامى أحمد صبحى ، محمد عباس رشيد ، حسن عبد الوهاب ، محمد حمزه سلام ، الحنفى أحمد صادق ، فايز صليب ، عبد الحليم الدمياطى ، بشاى جندى بشاى ، محمد نسيم .

١ — تلا السكرتير العام محضر الجلسة العلنية المنعقدة فى أول ديسمبر سنة ١٩٥٨ باللغتين العربية والفرنسية ، وتمت الموافقة عليه .

٢ — عرض السكرتير العام كتباً وردت هدية للمجمع من السيدين : نقولا زياده وجمال محسّب .

شكر الرئيس صاحبى الإهداء .

٣ — ألقى الدكتور سلامه طوسون بحثه : « التحلل الطيفى الانفراجى فى المعادن والسمك الظاهرى للإيسوجير » . وعلّق على البحث الأستاذ مصطفى نظيف .

٤ — ألقى الدكتور محمد حلمى الجبالى بحثه : « أثر تنعيم الجبس الزراعى فى سرعة إصلاح الأراضى القلوية » . وعلق على البحث الأستاذ مصطفى عامر ، والدكتور إلهامى جريس ، والدكتور سلامه طوسون .

ورفع الرئيس الجلسة الساعة السادسة والدقيقة ٥٥ مساء .

السكرتير العام

الدكتور بشر فارس

١ — تلا السكرتير العام محضر الجلسة العلنية المنعقدة فى ١٩ مايو سنة ١٩٥٨ باللغتين العربية والفرنسية ، وتمت الموافقة عليه .

٢ — عرض السكرتير العام حفنة من المؤلفات مهداة إلى المجمع من السادة : على شافعى ، زاهر رياض ، حسن الباشا ، حسن محمود ، عبد الرؤوف على يوسف ، محمد مصطفى ، بشر فارس ، هنريو وباتيو ، بيير كيزيل ، أنطونيو جيريرو ، أ . ألفييرى .

ومن الهيئات : الأكاديمية الملكية فى بلچيكا وجامعة مدريد .

شكر الرئيس أصحاب الإهداء .

٣ — هنأ الرئيس الدكتور بول بالوج ، عضو المجمع ، بتعيينه عضو شرف فى اللجنة الدولية لعلم النميات ، التى مقرها فى لاهاى ، والتابعة للمجلس الدولى للعلوم التاريخية .

٤ — ألقى الدكتور حامد زكى كلمة تأبين فى المرحوم محمد كامل مرسى ، عضو المجمع السابق .

٥ — ألقى الدكتور بشر فارس بحثه : « أربع تصاوير عربية : ساعة القصر . ثلاثة طلاسم » . (مع عرض بالفانوس السحرى) .

٦ — ألقى الدكتور عبد الحليم منتصر البحث الذى هيأه مع الدكتور صبرى علوان عن : «كائنات التربة المجهرية وأثرها فى توزيع النباتات الصحراوية ونموها » . وقد علق على هذا البحث الدكتور حامد زكى والأستاذ مصطفى نظيف .

ورفع الرئيس الجلسة الساعة السابعة والدقيقة ٢٠ مساء .

السكرتير العام

الدكتور بشر فارس

محضر الجلسة العلنية المنعقدة يوم الاثنين أول ديسمبر سنة ١٩٥٨

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

مصطفى نظيف	الرئيس
خ . أفيرينوس	نائبا الرئيس
مصطفى عامر	نائبا الرئيس
بشر فارس	السكرتير العام
لويس كرستوف	السكرتير العام المساعد

واعتذر عن التغيب : الدكتور سامى جبره ، أمين الصندوق والمكتبة .

أعضاء عاملون :

السادة : الأب چورچ قنواتى ، إلهامى جريس ، منصور فهمى ، محمد مصطفى ، كامل عثمان غالب ، ب . بالوج ، أ . ألفييرى .

أعضاء منتسبون :

السيد / حسن عبد الوهاب .

الجمهور :

السيدات : هـ . بالوج ، م . يونجفلايش .

والسادة : عبد الحليم منتصر ، بنهاوى ، شلبى ، رستم ، فوزى عامر ، محمد أبو الفتح ، إميل شنوده ، وليم رزق الله ، يوسف حسن ، فارس نبيه ، عبد الحليم كامل ، يوسف نحاس ، عز الدين سعيد .

جدول الأعضاء :

— عيّن الدكتور بول بالوج ، العضو العامل بالمجمع ، عضواً شرفياً للجنة الدولية لعلم النميات بمدينة لاهاى .

— عين الدكتور خ . أفيرينوس ، العضو العامل بالمجمع ، عضواً مراسلا لأكاديمية أثينا .

— أسف المجمع خلال هذه الدورة لفقد المرحوم مرسيل يونجفلايش ، العضو العامل .

وكان المجمع يتكون عند انتهاء الدورة من :

٤٥ عضواً عاملا (عدد الكراسى ٥٠) .

٤٨ عضواً منتسباً (عدد الكراسى ٥٠) .

٢٤ عضواً مراسلا (عدد الكراسى ٥٠) .

(انظر كشف الأعضاء من الفئات الثلاث ص ١٧٨) .

محاضر الجلســـات العلنية

محضر الجلسة العلنية المنعقدة يوم الاثنين ١٠ نوفمبر سنة ١٩٥٨

انعقدت الجلسة فى مقر المجمع الساعة السادسة مساء .

حضرها : هيئة المكتب : السادة :

مصطفى نظيف . . . . الرئيس

خرستو أفيرينوس . . . } نائبا الرئيس

مصطفى عامر . . . . . }

بشر فارس . . . . السكرتير العام

سامى جبره . . . . أمين الصندوق والمكتبة

لويس كرستوف . . . . السكرتير العام المساعد

أعضاء عاملون :

السادة : الأب ج . قنواتى ، ش . كونتز ، ب . بالوج ، عثمان رستم ، إلهامى جريس ، حامد زكى ، أ . ألفييرى ، منصور فهمى ، مراد كامل ، اسماعيل راتب .

أعضاء مراسلون :

السيد / ابراهيم المويلحى .

الجمهور :

السيدات : ه . عكاوى ، أ . خيرت ، ج . تسمانى ، ن . بباوى .

والسادة : محمد حسنين ، عبد الحليم منتصر ، زكى ابراهيم ، أبو بكر خيرت ، ا . كومب .

تقرير عن نشاط المجمع العلمى المصرى

خلال دورة ١٩٥٨ / ١٩٥٩

الجلسات :

عقد المجمع فى هذه الدورة ست جلسات ألقى فيها إثنا عشر بحثا فى مختلف العلوم والفنون والآداب .

تبادل المطبوعات :

بادل المجمع مطبوعاته مع نحو ٢٥٠ جمعية علمية مصرية وأجنبية .

المكتبـــة :

تلقت المكتبة خلال السنة ٣٣٥ كتاباً على سبيل الإهداء فضلا عن المطبوعات الدورية التى تصلها من الهيئات العلمية فى مختلف أنحاء العالم بطريق التبادل ، وقد بلغت محتويات المكتبة ٤١٣١١ كتاباً .

مؤتمرات :

اشترك الدكتور بشر فارس ، السكرتير العام للمجمع ، والدكتور منصور فهمى ، العضو العامل ، فى المؤتمر الرابع لرجال الأدب العرب المنعقد بالكويت فى ديسمبر سنة ١٩٥٨ ، وذلك بناء على دعوة خاصة من الحكومة الكويتية .

مجلة
المجمع العلمي المصري

المجلد الأربعون

(١٩٥٨ – ١٩٥٩)

القاهرة
مطبعة المعهد العلمي الفرنسي للآثار الشرقية
١٩٦٤

مجلة

المجمع العلمي المصري



مجلة المجمع العلمي المصري

المجلد الأربعون

(١٩٥٨ – ١٩٥٩)

القاهرة
مطبعة المعهد العلمي الفرنسي للآثار الشرقية
١٩٦٤